

ORIGINAL ARTICLE

## Genetic potential and breeding value of animals – an essential component of the genetic progress in dairy cattle

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The genetic potential and actual productivity of cows depend on their breed. In controlled farms, the higher expected and the actual yields were noted by the first-born cows of the Holstein breed. Expected yields of higher lactation in cows of both breeds were almost at the same level, but with higher actual productivity animals of the Ukrainian Black-and-White dairy breed. By degree of implementation, genetic potential in both controlled herds were the best cows of the Ukrainian Black-and-White dairy breed, at the same time above its value was observed in animals of Private joint-stock company "Plemzavod Stepnoy". We found that with increasing the share of Holstein heredity, the genetic potential of cows- first-borns in both herds increased, and the degree of its implementation decreased. There was a high advantage in realizing the potential genetic productivity of first-born lines P.F.A. Chifa and R.O.R.E. Elevation in Limited liability company "Veleten" and lines R.O.R.E. Elevation and K.M.I. Bella in Private joint-stock company "Plemzavod Stepnoy" above the same age cows of the other lines indicates the possibility of staffing of highly productive herds of animals of these lines. By breeding value by the yields of fathers of bulls, parents of cows, mothers of bulls, and mothers of cows in the second farm predominated the corresponding category of animals in the first farm. At the same time, the highest breeding value in both farms had the fathers of bulls, and the smallest – the mothers of cows, and therefore the contribution of paternal ancestors to the effect of selection by yields is much higher than maternal. Genetic progress on milking in Private joint-stock company "Plemzavod Stepnoy" was 89.8 kg, which is more than in Limited liability company "Veleten" by 43.2 kg. The contribution of four categories of breeding animals of the Ukrainian Black-and-White dairy breed in genetic improvement of the herd Limited liability company "Veleten" was 1.5 times higher than similar categories of Holstein breed. Private joint-stock company "Plemzavod Stepnoy" although insignificant, but Holsteins made a more significant contribution to the genetic improvement of the herd. In controlled herds, animals were characterized by high genetic potential, which was realized by 84.7%. Higher Holstein cows were marked by expected and actual milk yields and the degree of realization of genetic potential – Ukrainian Black-and-White dairy breed. The highest breeding value in both herds was characterized by the parents of bulls, while the smallest – by the mothers of cows. Therefore the contribution of paternal ancestors in the effect of selection by milking was much higher than maternal. Genetic progress in yields in farms was 46,1 – 89.8 kg. The contribution of four categories of breeding animals of the Ukrainian Black-and-White dairy breed in the genetic improvement of the herd Limited liability company "Veleten" was 1,5 times higher than the contribution of similar categories of Holstein breed. In the Private joint-stock company "Plemzavod "Stepnoy", though insignificant, a more significant contribution to the genetic Holstein improved the herd.

**Key words:** breed, cows, yields, genetic potential, degree of implementation, genetic progress.

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### Introduction

One of the most important tasks of young cattle breeding is to increase the genetic potential of productivity of cows, which largely depends on the effectiveness of qualitative improvement and consolidation of dairy breeds of cattle and rational use of the best genetic resources, starting from the correct and timely usage of modern science, principles and methods of large-scale selection (Pidpala & Bondar, 2012; Saksa, 2014; Mazurov et al., 2018; Bomko et al., 2018; Borshch et al., 2020; Grymak et al., 2020; Slivinska et al., 2020; Roman et al., 2020). The profitability of milk production depends a lot on the level of the genetic

potential of the dairy herd. On its basis, the feeding rations of animals are calculated, milk production is planned. Further selection work is also planned, as the development of breeding programs should be based on the current productivity level and genetic potential of animals in optimal feeding, keeping, and care conditions. Determining the implementation degree of the expected performance is necessary to determine the optimal conditions that contribute to its most entire manifestation (Novikov et al., 2015; Mazur et al., 2020).

The industrial technology of dairy cattle-breeding applies some requirements to animals' quality. Along with high productivity capabilities, they must have the ability to perform in any conditions. Breeding bulls have an important place in the creation of such animals. A big focus should be on bulls, which are enhancers in any herd, as holders of highly consolidated heredity and give their offspring high level of adaptation, allowing in different conditions to realize its genetic potential of productivity. It is also possible to achieve high genetic potential of productivity by improving the feed base and improving the quality of feed, creating the best exploitation conditions of breeding animals, by targeted rearing of offspring, implementation of modern technologies in the sphere of zootechnical and veterinary practice (Igna et al., 2010).

However, it should be kept in mind that the organization of targeted rearing of replacement heifers is one of the key steps to get heifers with more than 5000 kg of milk yield. Besides, the focus should be on daughters from highly productive mothers during selecting heifers (Danshin et al., 2017).

The progress of genetic improvement of each specific dairy cattle population depends on identifying the most valuable animals in terms of breeding, the intensity, and effectiveness of their use. The genetic advantage of both father and mother in the selection process depends on their genotype (candidate for selection) and the genetic variability of the selected trait. Genetic variability is provided mainly by biological features of the population, which significantly limits the breeder's influence on its increase (Eketone et al., 2018).

It is known that the improvement of dairy cattle on a large scale is possible with the transfer of genetic information from breeding animals of 4 categories: fathers and mothers of breeders and fathers and mothers of daughters. Each category of breeding animals contributes different proportions of impact on genetic improvement of the population due to the different abilities of genotype assessment, the intensity of selection, and use (Rudyk, 2010; Rudyk & Oleshko, 2010; Danshin et al., 2017; Pidpala et al., 2018). Under optimal conditions of the external environment, the degree of realization of genetic potential will grow, the level of milk productivity will go up, and the economic efficiency of milk production will increase (Babenko et al., 2016). Based on the above, the purpose of our research was to determine the genetic potential of Ukrainian Black-and-White dairy and Holstein breeds by the milk yield, the degree of its realization, and genetic progress in the experimental herds.

## Materials and methods

The research was on Ukrainian Black-and-White dairy (UBWD) and Holstein (H) cows in Limited liability company "Veleten" of Hlukhiv district (n = 1956) Sumy region and Private joint-stock company "Plemzavod "Stepnoy" of Kamyansko-Dniprovskoho district of Zaporizhia region (n = 1981).

The origin of bulls, their linear affiliation, breeding value, and milk productivity of their female ancestors were determined by the dairy cattle management system "Intesel Orsek" and catalogs of bulls.

The genetic potential of cows was calculated by the formula (Basovskij, 1983):

$$UGP = \frac{Ym}{GPP},$$

where,  $UGP$  – the usage of the genetic potential of productivity, %;

$Ym$  – milk yield of cow, kg.

$GPP$  – The genetic potential of herd productivity (kg), calculated by the formula:

$$GPP = \frac{M+MF}{2},$$

where  $M$  – milk yield of mother, kg;

$MF$  – milk yield of father's mother, kg

The average annual genetic progress was calculated by the method of N.Z. Basovskiy (Basovskij, 1983):

$$\Delta G = \frac{I_{fb}I_{fc}I_{mb}I_{mc}}{L_{fb}L_{fc}L_{mb}L_{mc}}$$

where,  $I_{fb}I_{fc}I_{mb}I_{mc}$  – genetic advantage of bulls' fathers, cows' fathers, bulls' mothers, cows' mothers;

$L_{fb}L_{fc}L_{mb}L_{mc}$  – generation intervals of categories of breeding animals.

Generation intervals of bulls' fathers ( $L_{fb}$ ) and cows' fathers ( $L_{fc}$ ) were calculated by the formulas:

$$L_{fb} = \frac{\Sigma[(Y_{d'}-Y_f) \times 365 + (M_{d'}-M_f) \times 30,5 + (D_{d'}-D_f)]}{365 \times nB/H}$$

where  $Y_{d'}$ ,  $Y_f$  – the last two figures of the year of birth of the descendant and father;

$M_{d'}$ ,  $M_f$  – the number of the month of birth of the descendant and father;

$D_{d'}$ ,  $D_f$  – the date of birth of the descendant and father;

$nB/H$  – the number of descendants;

$$L_{fc} = a \times L_{vsc} + (1 - a) \times L_{usc}$$

where  $L_{vsc}$  – generation interval of verified sires;

$L_{usc}$  – generation interval of unverified sires;

$a$  – the share of daughters of estimated sires compared with the total number of daughters of all sires at the time of calculations.

Statistical data processing was calculated with STATISTICA-10 software.

## Results

The results of our researches show that cows in the Private joint-stock company "Plemzavod "Stepnoy" had better-expected milk yield for the first and higher lactation and compared to cows in Limited liability company "Veleten" it was 572.4 and 593.7 kg, respectively, at  $P < 0.001$  in both cases (Table 1). In terms of actual productivity during the first and higher lactations, the cows in "Plemzavod "Stepnoy" also had better productivity. The most likely advantage of their milk yield over the cows of LLC "Veleten" was 702.6 and 509.4 kg, respectively. The realization of the genetic potential of cows of PJSC "Plemzavod "Stepnoy" was higher only for the first lactation - by 1.8%, and for higher lactation, in both farms, it was at the same level - 84.7%.

**Table 1.** Genetic potential of cows by milk yield and the degree of its realization,  $M \pm m$

Lactation	Breed	n	Genetic potential by milk yield, kg	Actual milk yield, kg	The degree of realization of genetic potential, %
LLC "Veleten"					
First	UBWD	748	9447.7±36.77***	8552.2±47.23	90.5
	H	189	9905.3±80.88	8665.8±88.07	87.5
	On herd	937	9540.0±34.10000	8575.1±41.69000	89.9
Higher	UBWD	748	11300.6±53.01	9640.3±59.23	85.3
	H	189	11348.9±100.06	9318.2±108.35**	82.1
	On herd	937	11310.3±46.86000	9575.3±52.24000	84.7
PJSC "Plemzavod "Stepnoy"					
First	UBWD	623	9860.6±43.92***	9120.0±62.11***	92.5
	H	515	10416.9±44.00	9468.5±81.35	90.9
	On herd	1138	10112.4±32.27	9277.7±50.36	91.7
Higher	UBWD	623	11902.1±64.89	10208.6±81.10	85.8
	H	515	11906.3±69.81	9934.7±89.57*	83.4
	On herd	1138	11904.0±47.52	10084.7±60.23	84.7

Note. \* - the validity of the difference when comparing the characteristics of cows of different breeds,  $\alpha^0$  - of different herds

It is known that the genetic potential and actual productivity of cows depend on their breed. In both farms, Holstein cows had the highest expected and actual milk yields during the first lactation. Their advantage over the animals of the Ukrainian Black-and-White dairy breed in LLC "Veleten" according to these indicators was 457.6 ( $P < 0.001$ ) and 113.6 kg, and in PJSC "Plemzavod "Stepnoy" - 556.3 ( $P < 0.001$ ) and 348.5 kg ( $P < 0.001$ ), respectively. The expected milk yield of higher lactation in cows of both breeds was almost at the same level, but the actual productivity was higher in animals of the Ukrainian Black-and-White dairy breed. In LLC "Veleten" cows had an advantage over the cows of Holstein breed by actual milk yield of higher lactation by 322.1 kg ( $P < 0.01$ ), and in PJSC "Plemzavod "Stepnoy" - by 273.9 kg ( $P < 0.05$ ).

We should note that cows of the Ukrainian Black-and-White dairy breed had a higher degree of realization of genetic potential for both lactations in both herds compared to Holstein, while cows in PJSC "Plemzavod "Stepnoy" had a higher value.

Given that Holstein sires were used for the reproduction of herds in both farms, we determined the genetic potential of cows, and the degree of its realization depended on the conditional share of Holstein heredity in the genotype of animals. We found that the increase of the share of Holstein heredity, the genetic potential of bred heifers in both herds increased, and the degree of its realization decreased. This can be explained by the fact that animals with a high share of Holstein heredity and with high milk productivity of the enhanced breed inherited from it more demanding requirements to conditions of the environment, the requirements to the conditions of keeping, care, and feeding. However, we determined that the bred heifers of PJSC Plemzavod "Stepnoy" realized their milk productivity potential better. Their milk yield advantage over the bred heifers in LLC "Veleten" ranged from 616.5 to 1311.5 kg at the most likely level, depending on the share of heredity of Holsteins. However, the cows with different Holstein blood in controlled herds for higher lactation though had most likely differentiation by the degree of realization of genetic potential, but it was much lower and depended on the share of Holstein heredity, 426.3-856.5 kg.

The effectiveness of the realization of the genetic potential of the controlled herd of cows in some way depends on their linear affiliation (Table 2). Thus, in LLC "Veleten" animals of the Marshall line had a most likely advantage by the expected milk yield of the first lactation, and depending on the line it was, 515.9-1739.4 kg. The indisputable proof of the realized high genetic potential of milk productivity by animals of this line is their most likely advantage on actual milk yield over the bred heifers of all other groups, and it was 480.2-1035.8 kg. In contrast, bred heifers of P.F.A. Chif and R.O.R.E. Eleveishn lines had the highest realization of the expected productivity - 97.6 and 97.3%.

Cows of the H.H. Starbak line had the best indicators of the expected milk yield for the higher lactation, and in fact, cows of the R.O.R.E. Eleveishn line had the best milk productivity. However, cows of P.F.A. Chif and R.O.R.E. Eleveishn lines were

characterized by, as well as during the first lactation, the highest degree of realization of the genetic capacity of milk yield – 98.5 and 98.0%, respectively.

**Table 2.** Genetic capacity for milk yield and the degree of its realization of different breed cows

Line	n	Genetic capacity for milk yield (M±m), kg	Actual milk yield (M±m), kg	The degree of realization of genetic capacity, %
<b>LLC "Veleten"</b>				
<b>First lactation</b>				
R.O.R.E. Eleveishn 1491007	68	8594.8±89.02***	8359.7±181.52***	97.3
Marshal 2290977	132	9916.0±54.28	9019.5±88.98	91.0
H.H. Starbak 352790	592	9400.1±36.44***	8539.3±51.96***	90.8
P.F.A. Chif 1427381	35	8176.6±69.62***	7983.7±277.02***	97.6
Other lines	110	10859.7±97.70	8555.7±115.12**	78.8
<b>Higher lactation</b>				
R.O.R.E. Eleveishn 1491007	68	10160.9±141.93***	9957.6±229.40	98.0
Marshal 2290977	132	10618.8±71.91***	9019.5±88.98***	84.9
H.H. Starbak 352790	592	11611.8±59.84	9627.9±66.94	82.9
P.F.A. Chif 1427381	35	9782.3±192.39***	9635.7±344.46	98.5
Other lines	110	12257.1±86.42	9703.5±145.36	79.2
<b>PJSC Plemzavod "Stepnoy"</b>				
<b>First lactation</b>				
K. M. I. Bella 1667366	120	9961.8±108.06*	9389.7±137.86	94.3
S.V.D. Valiant 1650414	237	10181.3±74.83	9224.7±107.84	90.6
R.O.R.E. Eleveishn 1491007	157	9950.1±92.80*	9412.5±133.95	94.6
H.H. Starbak 352790	132	10285.6±116.29	9129.4±162.01	88.8
P.F.A. Chif 1427381	440	10056.5±43.96	9267.3±76.48	92.2
Other lines	52	10668.6±86.35	9318.9±351.69	87.3
<b>Higher lactation</b>				
K. M. I. Bella 1667366	120	11620.8±151.14***	10074.4±169.13	86.7
S.V.D. Valiant 1650414	237	12480.5±96.26	10055.0±129.70	80.6
R.O.R.E. Eleveishn 1491007	157	12436.2±155.02	10443.4±174.28	84.0
H.H. Starbak 352790	132	12170.8±173.52	9929.3±187.08*	81.6
P.F.A. Chif 1427381	440	11500.1±59.01***	10112.5±91.36	87.9
Other lines	52	11063.0±129.76***	9318.9±351.69**	84.2

In PJSC Plemzavod "Stepnoy" bred heifers of H.H. Starbak line had the highest genetic capacity in terms of productivity, but cows of the R.O.R.E. Eleveishn line had the highest actual milk yield. Simultaneously, the best-expected performance was realized by the R.O.R.E. Eleveishn line bred heifers and K.M.I. Bella line – by 94.6 and 94.3%, respectively.

The expected milk yield for higher lactation showed a slightly higher and most reliable level of intergroup differentiation between cows of different linear affiliations. The animals of the S.V.D. Valiant and R.O.R.E. Eleveishn lines had the highest value of this indicator. The highest actual milk yields also characterized the last ones. Their advantage over other lines cows was in the range of 330.9–514.1 kg, however, according to milk yield genetic capacity, the P.F.A. Chif and K.M.I. Bella lines animals were the best.

Thus, according to the expected and actual milk yields during the first and higher lactation, the advantage was on the side of the animals in PJSC "Plemzavod "Stepnoy". However, the realization of the genetic capacity of cows of this herd was higher only during the first lactation, and for the higher one - was at the same level in both farms.

We considered that the Ukrainian Black-and-White dairy breed cows were characterized by a higher degree of realization of genetic capacity for both lactations in both controlled herds than Holstein, while animals in PJSC "Plemzavod "Stepnoy" had the highest value.

We registered that realization of genetic capacity for milk yield decreased with the increase of the conditional share of heredity of the Holstein breed. In both farms, Holstein cows had the highest expected and actual milk yields during the first lactation. The expected milk yield of the cows of both breeds was almost at the same level for higher lactation, but cows of the Ukrainian Black-and-White dairy breed showed higher actual productivity.

The bred heifers of P.F.A. Chif and R.O.R.E. Eleveishn lines in LLC "Veleten" and R.O.R.E. Eleveishn and K.M.I. Bella lines in PJSC "Plemzavod "Stepnoy" had a significant advantage over the bred heifers of the other lines in realizing the genetic capacity of the productivity, which indicates the possibility of generation of highly productive herds of animals of these lines.

In dairy cattle breeding, the effectiveness of genetic improvement of economically beneficial features depends on some factors. All of them are components of the selection process, where genetic progress is primarily assessed. The latter, of course, depends on the biological characteristics of the population, the sequence of stages of selection measures, livestock systems, and methods of animal evaluation. The main factors influencing the amount of genetic progress in the dairy population are the genetic advantage of 4 categories of breeding animals (fathers of bull, mothers of bulls, fathers of cows, and mothers of cows) and the duration of generation intervals (Admina, 2009; Rudyk, 2010; Rudyk & Oleshko, 2010).

We found that the categories mentioned above of breeding animals into the genetic improvement of controlled herds are different (Table 3). Thus, in terms of breeding value of milk yield, fathers of bulls, fathers of cows, mothers of bulls, and mothers of cows in PJSC "Plemzavod "Stepnoy" outperformed the corresponding category of animals in LLC "Veleten" by 359, 361,

respectively; 72 and 242 kg. We must underline that fathers of bulls had the highest breeding value in both farms, and the mothers of cows – the lowest. The total genetic advantage of four categories of breeding animals in PJSC "Plemzavod "Stepnoy" in comparison with LLC "Veleten" was 1034 kg of milk yield.

Differentiation according to the level of breeding value of the studied categories of breeding animals caused different amounts of genetic progress in herds: in PJSC "Plemzavod "Stepnoy" it is 89.8 kg of milk yield, and it is by 43.2 kg more than in LLC "Veleten".

**Table 3.** Breeding value (BV), generation interval (GI), and input of 4 categories of breeding animals in the genetic progress of populations by milk yield

Category of breeding animals	LLC "Veleten"				PJSC "Plemzavod "Stepnoy"			
	N	BV, kg	GI, years	input, %	n	BV, kg	GI, years	input, %
Fathers of bulls	17	588	6.2	55.6	28	947	4.0	45.3
Father of cows	19	274	8.4	25.9	40	635	9.2	30.4
Mothers of bulls	19	190	3.7	17.9	40	262	6.6	12.5
Mothers of cows	937	6	4.4	0.6	1138	248	3.5	11.8
Sum of all categories	-	1058	22.7	100.0	-	2092	23.3	100.0
Genetic progress	-	46.6	-	0.60	-	89.8	-	1.05

Differences in the breeding value of the bulls' and cows' fathers and the bulls' and cows' mothers caused different inputs of these categories into the genetic improvement of the herd. We established that the fathers made the most significant input into the genetic progress of milk yield of bulls, and the smallest – by the mothers of cows, which is probably due to the low intensity of selecting this category of animals.

We supposed that the increase of the number of fathers of bulls increases the input to selecting mothers of bulls by milk yield. Thus, a much larger number of fathers of bulls in PJSC "Plemzavod "Stepnoy" gave a lower contribution to the genetic progress by milk yield than in LLC "Veleten" by 10.3%, while the contribution of mothers of bulls, on the contrary, was higher by 5.5%.

Thus, our research has shown that father-ancestors have a much higher contribution to the effect of selection by milk yield than mothers. We established the dependence of the level of the breeding value of the fathers of bulls and cows, mothers of bulls and cows, and their generation interval on the breed affiliation (Table 4). Thus, the sum of breeding value for all the categories named above of animals of the Ukrainian Black-and-White dairy breed in LLC "Veleten" was 1137 kg, which is by 396 kg more than the Holstein breed, and the average annual genetic progress due to their selection was higher by 12.7 kg. In the population of the Ukrainian Black-and-White dairy breed of PJSC "Plemzavod "Stepnoy" in comparison with the population of the Holstein breed, these indicators, on the contrary, were lower by 218 and 17.2 kg, respectively.

**Table 4.** Breeding value (BV), generation interval (GI), and input of 4 categories of breeding animals that are influenced by milk yield on the genetic progress of different breeds.

Category of breeding animals	Ukrainian Black-and-White dairy breed				Holstein breed			
	n	BV, kg	GI, years	input, %	n	BV, kg	GI, years	input, %
<b>LLC "Veleten"</b>								
Fathers of bulls	16	639	6,3	56,2	12	384	6.2	51.8
Father of cows	18	284	8,4	25,0	14	232	8.1	31.3
Mothers of bulls	18	209	3,9	18,4	14	116	3.0	15.7
Mothers of cows	748	5	4,7	0,4	189	9	3.2	1.2
Sum of all categories	-	1137	23,3	100,0	-	741	20.5	100.0
Genetic progress	-	48.8	—	0.64	-	36.1	—	0.42
<b>PJSC "Plemzavod "Stepnoy"</b>								
Fathers of bulls	28	901	4.2	45.2	34	1003	3.8	45.3
Father of cows	39	520	9.6	26.1	34	775	8.7	35.0
Mothers of bulls	39	232	6.4	11.3	25	299	6.9	13.5
Mothers of cows	623	341	4.0	17.1	515	135	2.8	6.1
Sum of all categories	-	1994	24.2	100.0	-	2212	22.2	100.0
Genetic progress	-	82.4	—	1.01	-	99.6	—	1.06

We found that the contribution of four categories of breeding animals of the Ukrainian Black-and-White dairy breed into the genetic improvement of the herd of LLC "Veleten" was 0.64, and PJSC "Plemzavod "Stepnoy" – 1.01%, i.e., in the first case it was more significant than Holstein breed by 0.20, and in the second – less by 0.05%.

Thus, in terms of breeding value, the fathers of bulls, fathers of cows, mothers of bulls, and mothers of cows in PJSC "Plemzavod "Stepnoy" outperformed the corresponding category of animals in LLC "Veleten". In this case, fathers of bulls had the highest

breeding value in both farms and the mothers of cows – the lowest, so the contribution of father-ancestors to the effect of selection by milk yield is much higher than mother-ancestors.

Genetic progress of milk yield in PJSC "Plemzavod "Stepnoy" was 89.8 kg, which is more than in LLC "Veleten" by 43.2 kg. The contribution of four categories of breeding animals of the Ukrainian Black-and-White dairy breed into the genetic improvement of the herd of LLC "Veleten" was 1.5 times higher than the contribution of similar categories of Holstein breed. Holsteins made a more significant contribution to the genetic improvement of the herd at PJSC "Plemzavod "Stepnoy".

## **Discussion**

Selection plays a significant role in the improvement of dairy cattle (Danshin et al., 2017). Thus, in the developed countries of the world, about 75% increase in milk productivity, which has occurred over the past few decades, was caused by genetic improvement, i.e., targeted selection (McDaniel, 2011). Genetic improvement of breeds requires the modernization of all selected elements, particularly the system of genetic value estimation (Ducrocq & Wiggans, 2015). Recently, scientists have proven the progress and advantage of the BLUP (Best Linear Unbiased Prediction) method by using an animal model over the method of estimating "daughters of the same year" in terms of determining the breeding value of sires and cows in dairy farming (Ducrocq & Wiggans, 2015). This method takes into account both environmental and genetic factors that affect the variability of performance features. Also, all the factors taken into account in the model are evaluated simultaneously, achieving the most reliable, unbiased prognosis of the genotype of the sires and, accordingly, increases the probability of selection of bulls-enhancers (Liang & Cabrera, 2015). The data we got in determining the genetic potential of cows and the degree of its realization suggests that the animals of controlled herds have a relatively high genetic potential of milk yield. However, the environmental conditions in farms have not fully met the needs of high-value genotypes yet, which reduces the realization of their genetic inclinations of milk yield with an increase in the conditional share of heredity of Holsteins. Simultaneously, the contribution of four categories of breeding animals of the Ukrainian Black-and-White dairy breed to the genetic improvement of the herd of LLC "Veleten" was 1.5 times higher than the contribution of similar categories of Holstein breed. Holsteins made a more significant contribution to the genetic improvement of the herd at PJSC "Plemzavod "Stepnoy". We noted that in populations of both breeds in both herds, fathers of bulls made the highest contribution to genetic improvement and mothers of cows – the smallest.

The average annual genetic progress of a population caused by the real genetic advantage of the parents and the total generation interval, which shows the average duration of time between the birth of parents and their offspring. The average interval of "mother-descendant" is 4–6 years in dairy farming and "father-descendant" – 5–7 years. Therefore, one of the reserves to increase the efficiency of selection programs is to accelerate the change of generations, i.e., to reduce the generation interval of all categories of breeding animals. It has been proven that increases over seven years of the generation interval of fathers of bulls result in actual loss of their sons' genetic advantage over the breeding stock of herd (Rudyk, 2010).

Acceleration of generational change is possible due to the widespread use of young, not valued by the quality of offspring, sires; the earlier start of breeding use of replacement bulls; reduction of the period of control inseminations of cows by evaluating each bull simultaneously in several herds; reduction of the age of the first calving and increase of the proportion of bred heifers in herds; use of semen of the found enhancers within one year; preliminary evaluation of bulls on the productivity of daughters by periods (first months) of lactation; use of personal computers for data processing of breeding records when evaluating sires. In general, the evaluation of sires by the quality of offspring should be planned in a way to obtain reliable information about their breeding value in a relatively short time (not more than 1–2 years) on a large number of daughters (not less than 90–100 heads) and in a sufficiently large number of herds (Mazurov et al., 2018).

We believed that today in dairy farming, several countries had made a transition from the traditional system of evaluation of breeding bulls by offspring to the system of genomic selection, in which young bulls are selected for reproduction at an early age based on the genomic evaluation of breeding value (Genomic Breeding Value, GBV) (Hayes et al., 2010; Börner et al., 2012; Bouquet & Juga, 2013; Pryce et al., 2014; Calus et al., 2015; Garrick & Fernando, 2015; Lu et al., 2015; Thomasen et al., 2016; Ettema et al., 2017; Reiner-Benaïm et al., 2017). However, the BLUP method is also used with this system, but in a modified form, as a genomic BLUP (Legarra et al., 2014; Ruban et al., 2016).

Thus, the progress of genetic improvement of each specific dairy population depends on the use of the most valuable in the breeding, meaning sires and cows, reduction of the generation interval of all categories of breeding animals (father and mothers of sires and fathers and mothers of daughters), creating optimal environmental conditions (feeding, keeping, care) and the level of selection of the herd.

## **Conclusion**

Bred heifers were characterized by high genetic potential, which was realized in the controlled herds by 84.7%. At the same time, Holstein cows were characterized by higher expected and actual milk yields, and the Ukrainian Black-and-White dairy breed had better indicators in the degree of realization of genetic potential. However, the increase of the conditional share of Holstein heredity in the genotype of animals reduces the realization of their genetic features. There is a significant advantage in the realization of the genetic potential of the productivity of the bred heifers of Chif and Eleveishn lines in LLC "Veleten" and Eleveishn and Bella lines in PJSC "Plemzavod "Stepnoy" over the bred heifers of the same year of the other lines.

In terms of breeding value, the fathers of bulls and cows and the mothers of bulls and cows in PJSC "Plemzavod "Stepnoy" outperformed the corresponding category of animals in LLC "Veleten". In this case, fathers of bulls had the highest breeding value in both herds, and the lowest – mothers of cows, so the contribution of father-ancestors into the effect of selection by milk yield was much higher than mothers' one. Genetic progress in milk yield in the first farm was 89.8 kg, which is 43.2 kg more than in the second. The contribution of four categories of breeding animals of the Ukrainian Black-and-White dairy breed to the

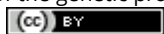
genetic improvement of the herd of LLC "Veleten" was 1.5 times higher than the contribution of similar categories of Holstein breed. Holsteins made a greater contribution to the herd's genetic improvement at PJSC "Plemzavod "Stepnoy".

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