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Influence of country of origin and lineage on the lifetime milk production of Holstein cows

Roman Mylostyvyi[1#], Volodymyr Kostiuk[2], Oleksandr Chernenko[1], Olena Khmeleva[1], Yulia Duda[1], Olena Izhboldina[1]

[1]Dnipro State Agrarian and Economic University, Sergii Efremov Str., 25, Dnipro, 49600, Ukraine;
[2]National University of Life and Environmental Sciences of Ukraine, Heroiv Oborony Str., 15, Kyiv, 03041, Ukraine

ABSTRACT

This work investigated the percentage influence of country of origin and lineage on parameters of lifetime milk production in Holstein cows brought as heifers to Ukraine from Western Europe. The animals were kept untethered in new, modern, uninsulated steel cowsheds in a large dairy complex. Data from the Orsek dairy management system were used to evaluate randomly selected cows of different origins with complete lactation for lifetime milk, fat and protein yield. Despite significant differences in milk productivity between animals depending on their country of origin and line, the share of the influence of these factors was fairly small. Two-way analysis of variance showed that the percentage influence of the line on lifetime milk yield was 5,5%, and its influence on the yield of milk fat and protein was 6,3-7,8%. The percentage influence of the country of origin was even smaller, at 0,5–2,6% (with a greater impact on milk yield). The rather small effect of the factors studied could be due to the influence of environmental factors (feeding and living conditions), which should be investigated in further studies.

KEY WORDS: Holstein cows, origin, line, milk production, influence of factors

INTRODUCTION

Finding ways to increase productive longevity is an important issue in dairy farming due to the decreasing length of the economic life of cows (Effa, 2013; Murray, 2013). This problem is especially acute among herds of highly productive cows, whose physiological functions are at the limit of their biological capabilities, often bordering on a pathological state (VandeHaar et al., 2016; Chebel et al., 2016).

[#] Corresponding author e-mail: mylostyvyi.r.v@dsau.dp.ua
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According to some authors (De Vries et al., 2017; Compton De Vries et al., 2017), this situation is a negative consequence of the commercialization of dairy cattle and unilateral selection for desired traits, accompanied by a decrease in the immune status, fertility, and productive life of animals, as well as a deterioration in milk quality (Milostiviy et al., 2017).

The productive longevity of cows is a fairly complex integral trait which is determined by both genetic and environmental factors (Weigel et al., 2017; Pytlewski et al., 2019). Among the former, the origin of the animals and the lineage of the parents have a significant impact, due to effective breeding subject to strict adherence to the selection system and assessment of animals according to their breeding value (Goncharenko, 2016). Therefore, there is a need for studies on the influence of paternal origin and lineage on parameters of lifetime productivity in dairy cattle. Modern computer systems for herd management and available databases on large numbers of animals in large dairy complexes enable the widespread use of statistical methods to determine the influence of environmental and genetic factors on production traits (Weigel et al., 2017). Therefore, the purpose of the study was to determine the percentage influence of the origin and lineage of Holstein cows at industrial dairy farms on their lifetime milk production.

MATERIALS AND METHODS

The study is part of the research project of the Department of Technology of Animal Production Processing entitled 'Ensuring sustainable development of animal husbandry and natural resistance under the influence of environmental and technological factors' (state registration number 0120U103848).

The work was carried out on imported Holstein cattle belonging to the joint stock company Agro-Soyuz in the Dnepropetrovsk region (48°28′44″ N, 35°36′46″ E) using data from the Orsek dairy management system. This enterprise was once a model farm for breeding Holstein cattle using the MAP information system for the selection of servicing bulls (economic assessment of selection options) of the company CRI, which met the latest requirements of the International Committee for Animal Recording (ICAR) and the International Bull Evaluation Service subcommittee (Interbull). Feeding conditions were identical for all animals, with the same mixture of concentrates and silage distributed to the feeding alleys year round. The animals were also kept in identical free-stall housing without insulation. The weather conditions in this region are typical for a temperate continental climate, with hot and mostly dry summers and relatively warm winters with frequent thaws. According to long-term data, the temperature fluctuations during the year are from +40°C in summer and to -34°C in winter, and the average annual temperature does not exceed +7,9°C.

Using a ten-year database, imported animals of European origin (Danish, German and Hungarian) were randomly selected from among cows with complete lactation (Antonenko et al., 2018). Cows with incomplete lactation (less than 240 days) were excluded from the sample. For all animals, the value of lifetime milk yield (kg), milk fat yield and milk fat protein (kg) were analysed. Data were presented as means ± standard error of the mean and subjected to analysis of variance (two-way ANOVA) using STATISTICA v. 10 (StatSoft, Inc., USA). The differences between the samples, determined by the Mann-Whitney U test, were considered significant at $P \leq 0,05$.

RESULTS AND DISCUSSION

Differences were revealed in the lifetime milk production in cows of different origins (tab. 1). The lifetime milk yield of imported Danish animals exceeded the herd average by 1336 kg (4%). For the yield of milk fat and protein, the differences were 73 kg (6%) and 61 kg (9%), respectively.

Table 1

Lifetime milk production of Holstein cows of different origins (mean ± SE)

Lifetime production indicators	Country of origin			Average for herd
	Danish n=52	German n=47	Hungarian n=49	
Milk yield, 1000 kg	35,6 ± 2,62^{a}	31,3 ± 2,07^{bc}	35,7 ± 2,16^{cb}	34,2 ± 1,33
Fat yield, 1000 kg	1,2 ± 0,08^{ab}	1,0 ± 0,07^{ab}	1,1 ± 0,08^{c}	1,1 ± 0,04
Protein yield, 1000 kg	1,0 ± 0,07^{a}	0,8 ± 0,06^{bc}	1,0 ± 0,06^{cb}	0,9 ± 0,03

Means with different superscripts a, b, c in the same rows are significant at $P \leq 0,05$.

The lifetime milk yield of cows of German origin was lower than the herd average by 2969 kg (8,7%). The yield of milk fat and protein during their productive life were below the herd average by 85 kg (8%) and 81 kg (11%), respectively. The lifetime milk yield of Hungarian cows exceeded the herd average by 1429 kg (4%). They provided 4 kg (0.4%) more milk fat and 39 kg (4%) more protein.

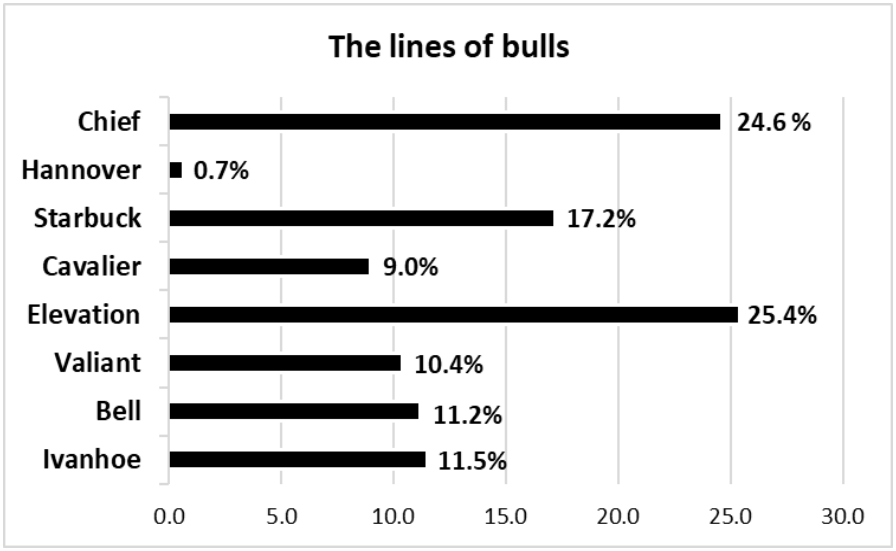

Fig. 1 Distribution of lines of servicing bulls in the herd of cows

The herd of Holstein cows brought to the farm as heifers was represented by the following lines of servicing bulls: Ivanhoe 1189870.50, Bell 1667366.74, Valiant 1650414.73, Elevation 1491007.65, Cavalier 1620273.72, Starbuck 352790.79, Hannover 1629391.72 and Chief 1427381.62 (fig. 1). The distribution of the lineage of European breeding cows was rather uneven. Thus, the Hannover line was the represented by the fewest cows, while the Elevation line was dominant. The assessment of economically useful traits was carried out for imported animals of six lines; the descendants of Ivanhoe and Hannover were not taken into account due to the small sample size.

The highest lifetime milk yield (tab. 2) among Holstein cows was noted in those of the Starbuck line, which surpassed their imported peers from other lines: Cavalier by 2819 kg (8%); Bell by 3404 kg (10%); Valiant by 5554 kg (18%); Elevation by 7369 kg (25%); and Chief by 5501 kg (17%).

Table 2

Indicators of lifetime milk productivity of cows of different lines (mean ± SE)

Line	Lifetime production, 1000 kg		
	milk yield	fat yield	protein yield
Cavalier 1620273.72	$34,4 \pm 5,11^{a}$	$1,07 \pm 0,18^{a}$	$0,96 \pm 0,12^{a}$
Bell 1667366.74	$33,8 \pm 4,49^{b}$	$1,15 \pm 0,11^{b}$	$1,02 \pm 0,09^{b}$
Valiant 1650414.73	$31,7 \pm 3,04^{c}$	$0,95 \pm 0,19^{c}$	$0,79 \pm 0,18^{cf}$
Elevation 1491007.65	$29,9 \pm 2,60^{df}$	$0,96 \pm 0,08^{d}$	$0,84 \pm 0,07^{d}$
Starbuck 352790.79	$37,3 \pm 3,21^{fd}$	$1,34 \pm 0,07^{fg}$	$1,08 \pm 0,06^{fc}$
Chief 1427381.62	$31,8 \pm 2,34^{g}$	$0,92 \pm 0,09^{gf}$	$0,92 \pm 0,08^{g}$

Means with different superscripts a, b, c … g in the same columns are significant at $P \leq 0,05$

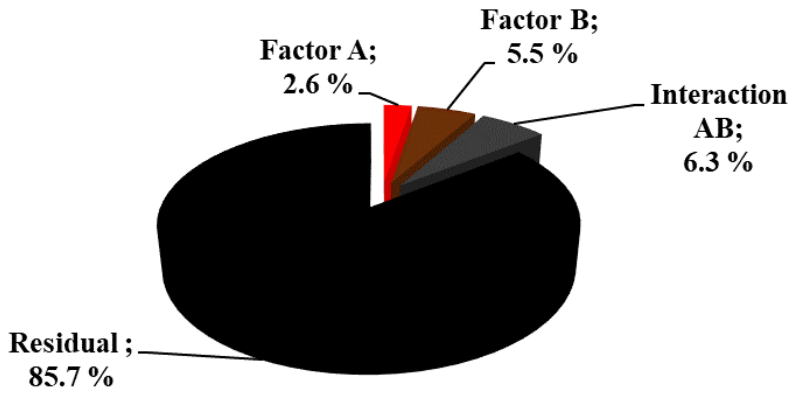

Fig. 2 The share of influence of factors on the lifetime milk yield of cows: country of origin (Factor A) and line (Factor B)

It should be noted that the Starbuck cows also had relatively high yields of milk fat and protein. Their superiority over cows of other lines in terms of these parameters was as follows: Cavalier by 274 kg (20%) and 116 kg (11%); Bell by 190 kg (14%) and 65 (6%); Valiant by 390 kg (29%) and 288 kg (27%); Elevation by 385 kg (29%) and 244 kg (23%); and Chief by 262 kg (19%) and 160 kg (15%).

Two-way analysis of variance was used to determine the percentage influence of the country of origin and lineage of cows as factors affecting lifetime indicators of their milk productivity. The proportion of the country of origin in the influence on the lifetime milk yield, fat yield and protein yield was up to 3%, with the greatest effect on milk yield. The proportion of the influence of the line of the cows was slightly higher, amounting to 8%, with a greater effect on the milk components. The percentage influence of the interaction of these factors only slightly exceeded that of the genealogical line on the parameters of lifetime production (fig. 2-4).

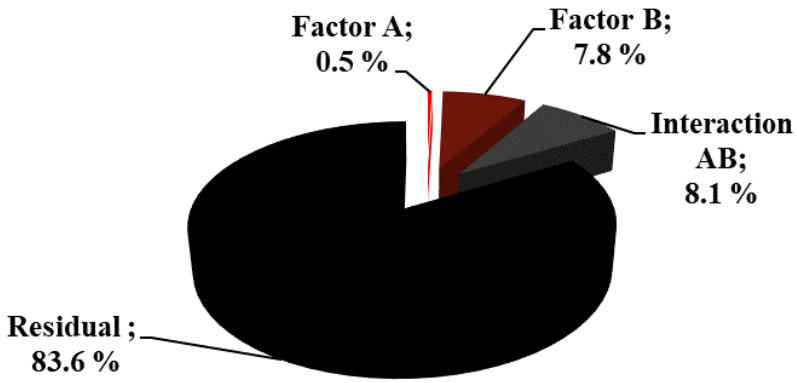

Fig. 3 The percentage influence of factors on the lifetime yield of milk fat: country of origin (Factor A) and line (Factor B)

Studies by other scientists (Babik et al., 2017) also indicate that the father's influence was significantly greater than that of the countries of origin of the bulls. Nevertheless, as in our study, the differences in milk yield and especially the yield of milk components in animals of various origins were significant (Milostiviy et al., 2017; Pytlewski et al., 2019). However, it should be noted that the influence of lineage on parameters of lifetime milk productivity proved to be relatively low (Babik, 2017) on both the father's side (16-19%) and the mother's side (10-11%).

In another study (Shulyar, 2019), one-way analysis of variance showed that the percentage influence of line on milk yield per lactation period was 9,5%, and its influence on lifetime indicators of milk productivity was even smaller (2,9-3,3%).

We are inclined to believe that the fairly low influence of the line and origin may be due to a significant effect of other factors. For example (Osipenko et al., 2018), the percentage influence of the factor of diet and protein content in the diet on milk protein content was 10-12%. The housing system also significantly influenced milk productivity. Comparison of the productivity of daughters

of the same line revealed that the milk yield of animals kept in free-stall housing was significantly higher than that of tethered cows (Voitenko & Zheliznyak, 2019).

In the case of year-round housing of cows in uninsulated buildings, as in the present study, environmental factors have a direct impact on the well-being and productivity of cows (Hempel et al., 2019; Mylostyvyi et al., 2020), especially in extreme weather conditions (Mylostyvyi et al., 2019).

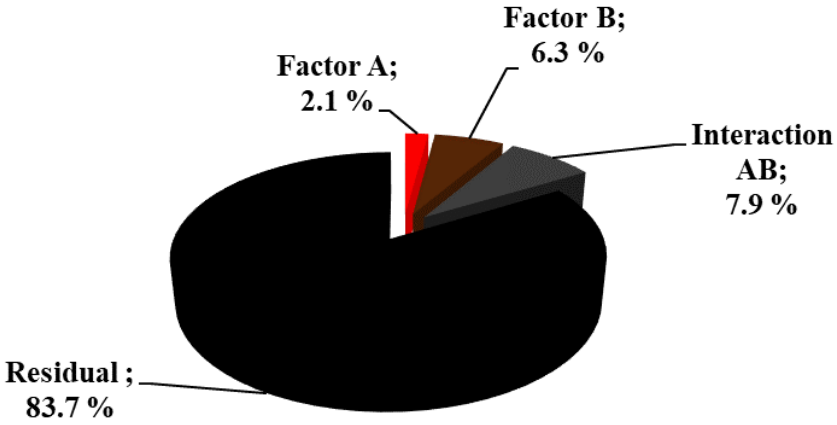

Fig. 4 The percentage influence of factors on the lifetime yield of milk protein: country of origin (Factor A) and line (Factor B)

In conclusion, the percentage influence of the lineage of bulls on lifetime indicators of milk production was small. This underscores the need to study the effect of environmental factors on the realization of genetic milk production potential in conditions of year-round housing of cows without a tether in uninsulated buildings, which will be the subject of our further research. The influence of the country of origin on lifetime milk production parameters was extremely small.

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