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LIFETIME PRODUCTION OF HIGH-YIELDING DAIRY COWS

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Abstract: Lifetime milk production is a key success factor in fulfilling the production potential of high-yielding cows. Lifetime milk production traits are pronouncedly variable. The life expectancy and the length of productive life of dairy cows are repeatedly limiting factors for improving lifetime milk production. Lifetime milk production is greatly depended on age at first calving and the number of lactations during productive life. Previous researches have implied there are real chances for improving the lifetime milk production of high-yielding cows. The goal of this research was to investigate the significance of key systematic factors on the lifetime production of high-yielding Black-and-White cows. The animals included in the sample had different share of Holstein genes. The researchers determined systematic factors that caused some significant phenotypic variations of the investigated trait. The average lifetime milk production was 25,002.66±7,755.39 kg. When observed by cow genotypes, the mean values of the lifetime milk production varied from 27,061.37 kg (<58% HF) and 24,761.26 kg (58-73% HF) to 23,185.36 kg (>73% HF). The differences in lifetime milk production determined among the animals were due to a highly significant ($p \leq 0.01$) impact of the bulls – the sires of the cows and the year of culling; the impact of the class of HF genes was significant ($p \leq 0.05$), whereas the impact of the reason for culling was non-significant ($p > 0.05$).

Key words: Holstein-Friesian cows, production, factors of impact

Introduction

The key factor of milk production economic efficiency is the lifetime production of high-yielding cows. Higher lifetime milk production ensures better economic results per cow. Economic efficiency is mostly a result of achieved milk production and longevity (*Heins et al., 2012; Martens and Bange, 2013*). Lifetime

milk production depends on age at first calving, the length of productive life and milk yield in certain lactations (*De Vries, 2008*).

An important characteristic of lifetime production is a high variability. Many factors can affect the lifetime productivity of high-yielding cows, most important of which is a breed, breed selection, the environment, feeding and fertility *(Petrović et al., 2007; Terawaki and Ducrocq, 2009)*. The genetic potential of an animal, expressed in existing conditions on a farm, is particularly important (*Páchová et al., 2005*). Milk yield per lactation has greatly increased in the last couple of decades, whereas in the same period productive life has shortened (*Hare et al., 2006*).

Higher lifetime milk production means that fewer cows are needed for the same scope of milk production on farms. The productive life and life expectancy of high-yielding cows under normal conditions enable improved lifetime milk production. In herds with intensive milk production, there are some problems that can considerably decrease economic results. The problems are often manifested as health disorders, infertility problems, and a high percentage of culling, short productive life and short life expectancy of cows (*Dechow et al., 2008*).

The odds for culling increase greatly with every next lactation (*Fetrow et al., 2006*). More culling per year shortens the period of productivity, thus decreasing the lifetime milk production of cows. Longer productive life ensures more lactations with higher milk production *(Donaldson, 2006)*. Longer life, higher milk production and more calves are characteristics of cows with good body composition (*Norman et al., 2007*). The utilisation rate of a cow is important in terms of determining the proportion of non-productive period in the total lifetime of a cow. If cows have more lactations, breeding costs to the time they reach sexual maturity are to be apportioned to a larger amount of milk obtained during several lactations.

Previous researches have implied there are great possibilities for improving the lifetime production of high-yielding cows. It is necessary to know the importance of environmental impact on the results of the lifetime production of high-yielding cows in order to include it in the model. Considering the importance of each systematic factor, the authors of this research gave their unbiased assessment to evaluate the results as accurate as possible.

The goal of this research was to investigate the significance of key systematic factors on the lifetime production of high-yielding Black-and-White cows with different share of Holstein genes.

Material and Methods

The investigation and analysis of key systematic factors on achieving lifetime production was conducted on a herd of Black-and-White cows. The

animals included in the sample were European type of Black-and-White cattle. During the research the cows were at the final stage of intensive breeding using Holstein genes. The high-yielding cows that were the subject-matter of this research were kept under the same housing conditions, feeding, care and method of utilisation.

A mathematical-statistical analysis of the impact of certain systematic factors was conducted with the method of least squares (*Harvey, 1987*). The advantage of this method is a possibility for concurrent and simultaneous determination of multiple factors that have an impact on the investigated trait. The following table with investigated factors shows animal distribution (N = 331) according to the previously defined classes:

Table 1. Animal distribution according to defined classes

Class of HF genes	<58%	58-73%	>73%
n	83	125	123

Year of culling	1	2	3
n	88	140	103

Reason for culling	1	3	4
n	278	47	6

Applied statistical model:

$$Y_{ijklm} = \mu + O_i + HF_j + G_k + R_l + e_{ijklm}$$

Where:

Y_{ijklm} = result of **m** cow, daughter of **i** sire, belonging to **j** group according to share of HF genes, culled in **k** year, because of **l** reason

μ = general average
O_i = impact of **i** sire
HF_j = impact of **j** group of HF genes
G_k = impact of **k** year of culling
R_l = impact of **l** reason for culling
e_{ijklm} = random error

Results and Discussion

Achieved lifetime milk production can greatly affect economic results. The productive period is a period from the first calving to culling. Lifetime milk production is achieved within the productive period.

The analysis of mean values (lsm), mean value errors (Slsm) of least squares and the significance of the investigated factors for the lifetime production of high-yielding Black-and-White cows is shown in Table 2.

Table 2. Mean values (lsm) and mean value errors (Slsm) of least squares for the investigated factors for lifetime milk production (kg)

Factors	N	lsm	Slsm
Total			
μ	331	25,002.66	7,755.39
Class of HF genes (df_1=2, df_2=307, $f\text{-}_{exp}$=4.007*)			
<58%	83	27,061.37	7,796.64
58-73%	125	24,761.26	7,779.84
>73%	123	23,185.36	7,787.97
Sires - bulls (df_1=17, df_2=307, $f\text{-}_{exp}$=31.858**)			
23	42	33,299.09	1,490.42
28	20	24,636.17	2,014.13
33	3	40,446.99	4,506.45
35	29	15,645.69	1,813.27
36	45	20,519.79	1,557.39
38	11	7,400.24	2,576.62
270	22	39,538.36	1,929.98
283	5	48,946.03	3,550.72
293	8	1,304.13	2,909.00
337	7	5,789.60	3,036.78
762	21	35,476.32	1,975.43
795	6	49,058.76	3,283.66
816	33	32,587.44	1,719.46
879	7	10,904.66	3,016.05
927	31	21,711.56	1,643.02
1,040	19	9,763.58	2,021.80
1,304	15	24,039.53	2,236.11
5,368	7	32,710.09	3,028.12
Year of culling (df_1=2, df_2=307, $f\text{-}_{exp}$=49.147**)			
1	88	19,725.90	7,772.39
2	140	24,086.81	7,783.63
3	103	31,195.29	7,789.04
Reason for culling (df_1=2, df_2=307, $f\text{-}_{exp}$=2.740ns)			
1	278	26,514.41	7,696.92
3	47	28,026.35	7,759.58
4	6	20,467.24	8,279.71

N.S.- $p>0.05$ *-$p\leq0.05$ **-$p\leq0.01$

The average lifetime milk production was 25,002.66±7,755.39 kg. The lifetime milk yield by cow genotypes ranged from 27,061.37 kg (<58% HF), and 24,761.26 kg (58-73%HF), to 23,185.36 kg (>73%HF).

The average lifetime milk production of 145 Holstein cows was 36,000 kg milk with 4.23% fat and 3.38% proteins. For a long time, average productive life was 4.5 lactations, but actual productive life was lower, ranging up to 3.5 lactations. One of the reasons for less lactations was the introduction of a larger number of young, first-calving cows to increase the size of a herd (*Martens and Bange, 2013*).

In Slovenia, a comparison between lifetime milk production of Holstein and Simmental cows was carried out according to their origin (*Janžekovič et al., 2009*). The subject-matter of that study were cows of Holstein breed (461 domestic - Slovenian cows and 356 cows of foreign origin) and Simmental breed (261 domestic and 43 foreign). The study included only cows with 1-9 lactations. The lifetime milk production of the domestic Holstein cows was 28,857.00 kg, and of foreign cows was 27,912.00 kg. The lifetime milk production of the domestic Simmental cows was 17,169.00 kg, and of foreign cows 21,519.00 kg. Statistically, significant differences ($p \leq 0.05$) were determined between the cows of domestic and foreign origin.

Donaldson (2006) states that the lifetime milk production of Holstein breed cows increases with longer life and more lactations. The interval between calving should be 380 days. As for milk yield, it should be 7,000.00 litres in the first lactation, 8,000.00 litres in second and 9,000.00 litres in the following lactations. Based on these values, lifetime milk production per cow according to the number of its lactations is, as follows: 7,000.00 litres in first, 15,000.00 litres in second, 24,000.00 litres in third, 33,000.00 litres in fourth and 42,000.00 litres in the fifth lactation.

The lifetime milk production of Black-and-White cows from two regions in south-western Romania was 16,461.10 kg in one, and 14,173.29 kg in the other region. The difference between these two lifetime productions was significant ($p \leq 0.05$) (*Bognar et al., 2011*).

Moreover, the average lifetime milk production of cows culled in 2013 was 24,254.00 kg for Black-and-White, 22,356.00 kg for Brown breed cows, 18,856.00 kg for Simmental cows and 22,465.00 kg for Simmental crossbreds (*Kmetijski inštitut Slovenije, 2014*).

From the investigated systematic factors, the impact of the sires - bulls and the year of culling on the differences in lifetime milk production was highly significant ($p \leq 0.01$), the impact of the class of HF genes was significant ($p \leq 0.05$), the impact of the year of culling highly significant ($p \leq 0.01$), whereas the impact of the reason for culling was non-significant ($p > 0.05$).

Conclusions

The average lifetime milk production was 25,002.66±7,755.39 kg. When observed by cow genotypes, the mean values of lifetime milk production varied from 27,061.37 kg (<58% HF), 24,761.26 kg (58-73% HF) to 23,185.36 kg (>73% HF). The differences in lifetime milk production determined among the animals were due to a highly significant ($p \leq 0.01$) impact of the bulls – the sires of the cows and the year of culling; the impact of the class of HF genes was significant ($p \leq 0.05$), whereas the impact of the reason for culling was non-significant ($p > 0.05$).

The results on lifetime milk production were affected by duration of productive life and increased number of culled cows, which had direct consequences on breeding and economic results. Lifetime milk production, achieved in complex conditions on cattle farms, has a great economic importance. Lifetime milk production traits should enable more efficient and more productive use of the genetic potential and life expectancy of cows.

Životna proizvodnja visokomlečnih krava

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Rezime

Osobine životne proizvodnje visokomlečnih krava imaju veliki ekonomski značaj. Crno-bela goveda imaju značajan genetski potencijal za proizvodnju mleka. Visokoproizvodne krave crno-bele rase izložene su tokom produktivnog veka velikom broju složenih uticaja koji intenzivno deluju na nivo relizacije njihovog genetskog potencijala. Uslovi sredine često nisu u saglasnosti sa potrebama ove visokomlečne rase goveda. Povećanjem učešća gena holštajn-frizijske rase, tokom procesa oplemenjivanja evropskog tipa crno-belih goveda, došlo je do povećanja prinosa mleka. Dosadašnja istraživanja ukazuju na mogućnost za značajnije povećanje životne produktivnosti crno-belih krava. Poznavanje broja i nivoa uticaja faktora sredine, na životnu proizvodnju visokomlečnih krava, važno je zbog njihovog uključivanja u model. U skladu sa značajem pojedinih sistematskih faktora u okviru istraživanja je obavljena njihova objektivna procena. Cilj rada je bio da se primenom odgovarajuće metodologije ispita značajnost razlika, u ostvarenoj životnoj proizvodnji mleka kod visokoproizvodnih crno-belih krava, preko najvažnijih sistematskih uticaja. Prosečna životna proizvodnja mleka iznosila je 25002.66±7755.39 kg litara. Posmatrano po genotipovima krava prosečne vrednosti životne proizvodnje mleka iznosile su 27061.37 kg (< 58% HF),

24761.26 kg (58-73% HF) i 23185.36 kg (> 73% HF). Utvrđene razlike između grla u pogledu ostvarenog nivoa životne proizvodnje mleka nastale su kao posledica visoko značajnog uticaja ($P \leq 0.01$) bikova-očeva krava i godine izlučenja krava, klasa HF gena krava imala je značajan uticaj ($p \leq 0.05$), dok razlog izlučenja nije imao značajan uticaj ($P > 0.05$).

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