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Effect of grazing on lifetime performance and longevity of Holstein and Slovak Spotted cattle

Vplyv pasenia na celoživotnú úžitkovosť a dlhovekosť dojníc holštajského a slovenského strakatého plemena

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ABSTRACT

The objective of the study was to analyse longevity and lifetime performance traits in dependence on access to grazing (G). Data of Holstein and Slovak Spotted dairy cows (143,566 and 30,412 heads culled between 2006 and 2019) were included. Within each breed, three groups of cows were considered: (1) cows not grazed throughout their entire life, (2) cows seasonally grazed as heifers (in summer), (3) cows seasonally grazed throughout their entire life (in summer). Eight (four longevity and four lifetime milk performance) traits were analysed. General Linear Model with fixed factors: G, herd nested within G, culling year, and cow's age at first calving as covariate was applied. Cows of group (1) had the highest 305-day milk yield: 8,005.0±7.1 kg (Holstein) and 5,985.3±13.0 kg (Slovak Spotted) and lifetime milk yield: 18,408.5±59.4 kg (Holstein) and 18,237.2±129.1 kg (Slovak Spotted). Holstein cows of group (1) had the highest length of productive life (882.4±2.5 days) and number of lactations (2.37±0.01). The highest length of productive life (1,298.0±16.4 days) and number of lactations (3.46±0.04) were found in Slovak Spotted cows of group (3). The best lifetime performance (regardless of breed) was expected in cows not grazed; whereas, the best longevity traits were expected in Slovak Spotted cows seasonally grazed throughout their lives. Surprisingly, in Holstein cows, the best longevity traits were found in animals that were not grazed. This suggests that the living conditions of housed Holstein cows did not negatively affect their longevity.

Keywords: cows, heifers, lifespan, milk production, grazing

ABSTRAKT

Cieľom tejto práce bolo analyzovať dlhovekosť a celoživotnú úžitkovosť dojníc v závislosti od toho, či dojnice mali alebo nemali prístup k pastve. Využili sme záznamy o mliekovej úžitkovosti dojníc holštajnského a slovenského strakatého plemena (143 566 and 30 412 kráv zabitých v rokoch 2006 až 2019). V rámci plemena sme kravy rozdelili na tri skupiny: 1) kravy bez celoživotného prístupu k letnej pastve, 2) kravy v lete pasené ako jalovice, 3) kravy s celoživotným prístupom k letnej pastve. Analyzovali sme osem ukazovateľov dlhovekosti a celoživotnej úžitkovosti. Použili sme štatistický model s pevnými faktormi: prístup k pastve, stádo v rámci prístupu k pastve, rok vyradenia a vek kravy pri prvom otelení (sprievodná premenná). Dojnice zaradené do skupiny 1) dosiahli najvyššiu produkciu mlieka za normovanú laktáciu (305 dní): 8 005,0±7,1 kg (hojštajnské) a 5 985,3±13,0 kg (slovenské strakaté) a celoživotnú produkciu mlieka: 18 408,5±59,4 kg (holštajnské) a 18 237,2±129,1 kg (slovenské strakaté). Holštajnské dojnice skupiny 1) mali najdlhší produkčný život (882,4±2,5 dní) a najvyšší počet laktácií (2,37±0,01). Naopak, najdlhší produkčný život (1 298,0±16,4 dní) a najvyšší počet laktácií (3,46±0,04) mali slovenské strakaté dojnice zaradené do skupiny 3). Skutočnosť, že dojnice bez prístupu k pastve (obe plemená) mali najlepšie výsledky ukazovateľov mliekovej úžitkovosti bola v súlade s očakávaním. Podobne boli v súlade s očakávaním najlepšie výsledky ukazovateľov dlhovekosti slovenských strakatých dojníc skupiny 3). Prekvapujúce bolo zistenie, že najlepšie ukazovatele dlhovekosti dosiahli holštajnské dojnice skupiny bez prístupu k pastve. To naznačuje, že životné podmienky ustajnených holštajnských dojníc neovplyvnili ich dlhovekosť negatívne.

Kľúčové slová: kravy, jalovice, dĺžka produkčného života, produkcia mlieka, pasenie

INTRODUCTION

Longevity and lifetime performance traits are good indicators of breeding effectiveness and animal welfare (Adamczyk et al., 2017). In dairy cows, these traits include: age at culling/length of life (days from birth to culling), length of productive life (days from first calving to culling), number of lactations per life, lifetime milk yield, average milk yield per day of life and average milk yield per day of productive life (Sawa et al., 2019). They are to a great extent complementary and their combinations provide a comprehensive evaluation of lifetime productivity of dairy cows since productivity is not only a function of length of life, but also a function of lifetime production (Adamczyk et al., 2017).

Similarly, length of productive life is determined by fertility and production ability (Dash et al., 2018). The age at first calving is also a good indicator of cow longevity and heifer rearing conditions (Krogmeier et al., 2015; Cielava et al., 2017); it also affects cow lifetime performance (Dákay et al., 2006; Sawa and Bogucki, 2010; Boothby et al., 2020). Theoretically, reducing of age at first calving may increase the number of lactations and allow for an earlier return on investment (Nilforooshan and Edriss, 2004). However, the age at first calving, has not been reduced much because it is believed that early calving is detrimental to milk yield and longevity (Pirlo et al., 2000). According to Do et al. (2013) and Krpálková et al. (2014), it should be properly managed to achieve a longer productive life, as farmers face a complex dilemma in minimizing the costs associated with raising of heifers. Appropriate treatment and adequate nutrition enable heifers to reach reasonable body weight and age at first calving, and to manifest their lifetime potential (Almasri et al., 2020). Hence, factors of farm and local conditions were found to influence age at first calving (Castillo Badilla et al., 2011; Valchev et al., 2020). Breed, housing system, herd size, herd production level and management criteria were reported to influence longevity and lifetime performance traits (Jankowska et al., 2014; Kučević et al., 2020). Moreover, grazing has been reported to have a significant effect on these traits as mentioned by Krogmeier et al. (2015).

Longevity and lifetime performance traits are not known until cows are culled and selection cannot be performed during their lives. One of the possible solutions to overcome the problem is the application of survival analysis techniques that allow to take into account partial information about cows that are still alive (Zavadilová and Štípková, 2013; Jenko et al., 2015). Contrariwise, analyses of already culled cows are important when assessing effectiveness of breeding strategies. These analyses were recently undertaken in various breeds: Holstein (Teke and Murat, 2013), Jersey (Boothby et al., 2020). With Slovak Spotted breed (local name for Simmental), the evaluation of length of productive life was done by Strapák et al. (2008), however, the effect of grazing was not investigated. Preliminary analyses of longevity and lifetime performance traits of Slovak Spotted breed were recently published by Huba et al. (2021).

The objective of the study was to analyse the longevity and lifetime milk performance traits of Holstein and Slovak Spotted cows in dependence on grazing, i.e. keeping the animals indoors or allowed to graze. Because of analyses of population data, calculations took into account variance of herd, year of culling (enabled to assess development of studied traits over time), and cow's age at first calving.

MATERIAL AND METHODS

Data of 143,566 and 30,411 purebred dairy cows of Holstein and Slovak Spotted breeds, culled between 2006 and 2019, were provided by the Breeding Services of the Slovak Republic. Eight longevity and lifetime milk performance traits: age at first calving (days), age at culling (days), length of productive life (days), number of lactations completed, lifetime milk yield (kg), 305-day milk yield (kg), milk yield per day of life (kg) and milk yield per day of productive life (kg) were analysed separately within each breed. Herds with information about grazing, partial grazing and not grazing of animals and at least consisted of 100 heads (large-scale herds) were taken into account (219 herds of Holstein breed and 78 herds of Slovak Spotted breed). Within each breed, cows were assigned to three groups: (1) cows not grazed throughout their entire life, (2) cows seasonally grazed as heifers (in summer) and (3) cows seasonally grazed throughout their entire life (in summer). General Linear Model as implemented in SAS (2009) was applied. The following model equation was used:

$$y_{ijkl}=\mu+S_i+Y_j+H_{k(i)}+b_1A_{ijkl}+b_2A^2_{ijkl}+e_{ijkl}$$

where:

y_{ijkl} - individual observations of investigated traits

μ - overall mean

S_i - fixed factor of grazing, not grazing, partial grazing; $\sum_i S_i=0$

Y_j - fixed factor of year of culling (2006, 2007, ... and 2019); $\sum_j Y_j=0$

$H_{k(i)}$ - fixed factor of herd nested within grazing, not grazing, partial grazing; $\sum_{k(i)} H_{k(i)}=0$

b_1 and b_2 - linear and quadratic covariates of cow's age at first calving (A); excluded when trait age at first calving was investigated

e_{ijkl} - random residual error; e_{ijkl}~$N(0,\delta_e^2)$.

Fixed factors were estimated using the Least Squares Means method. Statistical significances of fixed factors were tested by Fischer's F-test, and statistical significances of individual differences between estimated levels of fixed factors were tested by Scheffe's multiple-range tests. The differences are considered as significant at P<0.01.

RESULTS AND DISCUSSION

The results of analyses of longevity and lifetime milk performance traits are given in Table 1. In Holstein breed, all included factors: grazing (G), herd nested within G, year of culling and linear and quadratic covariates of age at first calving showed significant influence (P<0.01) on all traits (covariates were not considered when trait age at first calving was analysed). In Slovak Spotted breed, different pattern was shown. Only G and herd within G significantly influenced all traits; year of culling showed non-significant effect (P>0.05) on age at culling, length of productive life and number of lactations. With exception of an average milk yield per day of life and milk yield per day of productive life, age at first calving (both linear and quadratic covariates) significantly influenced lifetime performance traits. The significance of herd on longevity and lifetime milk performance traits agreed with findings of Strapák et al. (2008) and Jankowska et al. (2014).

Kučević et al. (2020) also confirmed the influence of herd and housing on these traits. Castillo Badilla et al. (2011) and Valchev et al. (2020) reported significant effects of herd and local conditions on age at first calving. The significance of age at first calving on lifetime milk performance traits agreed with reports of Dákay et al. (2006), Sawa and Bogucki (2010) and Boothby et al. (2020).

The estimates of least square means and standard errors of means of longevity and lifetime milk performance traits in dependence on G are given in tables 2a (Holstein) and 2b (Slovak Spotted). In Holstein breed, group (1), i.e. cows not grazed throughout their entire life, had the significantly lowest age at first calving: 806.5±0.3 days vs. 835.5±1.08 days (group (2), i.e. cows seasonally grazed as heifers) and 879.2±1.3 days (group (3), i.e. cows seasonally grazed throughout their entire life). Cows of group (1) had the highest age at culling (1,677.6±2.5 vs. 1,604.1±7.8 and 1,617.8±10.4 days), length of productive life (882.4±2.5 vs. 808.4±7.8 and 822.5±10.4 days) and number of lactations (2.37±0.01 vs. 2.22±0.02 and 2.28±0.03) when comparing with the remaining groups.

Table 1. Analyses of General Linear Model (statistical significance of Fisher's F-test) by breed

Trait/Fixed effect	Holstein Class Grazing	Year of culling	Herd (MS[1])	Covariate Age at 1st c.[2]	Age[2] at 1st c.[2]
Age at 1st calving (d[3])	**	**	**	Not considered	Not considered
Age at culling (d[3])	**	**	**	**	**
Productive life (d[3])	**	**	**	**	**
Number of lactations	**	**	**	**	**
Lifetime milk yield (kg)	**	**	**	**	**
305-d[3] milk yield (kg)	**	**	**	**	**
Milk/d[3] of life (kg)	**	**	**	**	**
Milk/d[3] of prod. life (kg)	**	**	**	**	**
Trait/Fixed effect	Slovak Spotted Class Grazing	Year of culling	Herd (MS[1])	Covariate Age at 1st c.[2]	Age[2] at 1st c.[2]
Age at 1st calving (d[2])	**	**	**	Not considered	Not considered
Age at culling (d[2])	**	-	**	**	**
Productive life (d[2])	**	-	**	**	**
Number of lactations	**	-	**	**	**
Lifetime milk yield (kg)	**	**	**	**	**
305-d[2] milk yield (kg)	**	**	**	**	**
Milk/d[2] of life (kg)	**	**	**	**	**
Milk/d[2] of prod. life (kg)	**	**	**	**	**

[1] calving; [2]day; ***P*<0.01

The differences between group (1) and groups (2) and (3) were significant; whereas, the differences between groups (2) and (3) were not significant. Kučević et al. (2020) reported higher age at culling, length of productive life and number of lactations for housed Holstein cows in Serbia when comparing to Holstein cows in Slovakia; nevertheless, age at first calving was similar (about 27 months). According to Adamczyk et al. (2017), cows in dairy industry usually live about six years (5.5 years in Holstein cows in Poland). Holstein cows in Slovakia lived shorter (4.5 years), probably due to different management and breeding strategies.

In Slovak Spotted breed, age at first calving was significantly lower (907.2±1.1 days) in cows not grazed when comparing with cows seasonally grazed as heifers (942.3±1.3 days) and cows seasonally grazed throughout their entire life (970.4±2.2 days). Cows of groups (3) and (2) had significantly higher ages at culling (2,219.6±16.4 and 2,153.4±9.4 vs. 2,100.0±7.9 days), lengths of productive life (1,298.1±6.4 and 1,231.8±9.4 vs. 1,178.4±7.9 days) and average numbers of lactations (3.46±0.04 and 3.31±0.02 vs. 3.22±0.02). The longer productive life in cows with seasonal access to pasture agreed with findings of Krogmeier et al. (2015) for grazed Fleckvieh cows. The length of life in Slovak Spotted cows (about six years) agreed with length of life in dairy cows reported by Adamczyk et al. (2017).

In Holstein cows, 305-day milk yield was in line with expectations: cows of group (1) had 305-day milk yield (8,005.0±7.1 kg) significantly higher than cows

Table 2a. Least squares means and standard errors of analysed traits in dependence on grazing (Holstein)

Trait/Grazing	(1) N	$\mu \pm s_\mu$	(2) N	$\mu \pm s_\mu$	(3) N	$\mu \pm s_\mu$
Age at 1st calving (d[1])	125,529	806.5 ± 0.3^A	13,294	835.2 ± 1.0^B	4,713	879.2 ± 1.3^C
Age at culling (d[1])	125,529	1,677.7 ± 2.5^A	13,294	1,604.1 ± 7.8^B	4,713	1,617.8 ± 10.4B^C
Productive life (d[1])	125,529	882.4 ± 2.5^A	13,294	808.8 ± 7.8^B	4,713	822.5 ± 10.4B^C
Number of lactations	125,529	2.37 ± 0.01^A	13,294	2.22 ± 0.02^B	4,713	2.28 ± 0.03B^C
Lifetime milk yield (d[1])	125,529	18,408.5 ± 59.4^A	13,294	15,869.2 ± 185.7^B	4,713	14,549.6 ± 247.6^C
305-d[1] milk yield (kg)	104,169	8,005.0 ± 7.1^A	10,895	7,597.2 ± 25.4^B	3,894	6,878,5 ± 29.7^C
Milk/d[1] of life (kg)	125,124	9.60 ± 0.02^A	13,246	8.63 ± 0.06^B	4,693	7.90 ± 0.09^C
Milk/d[1] of prod. life (kg)	125,124	20.13 ± 0.03^A	13,246	18.83 ± 0.08^B	4,693	17.27 ± 0.10^C

(1) cows not grazed; (2) cows seasonally grazed as heifers; (3) cows seasonally grazed throughout their entire life; [1] day; ^{ABC} means with different superscript differ at *P*<0.01

Table 2b. Least squares means and standard errors of analysed traits dependence on grazing (Slovak Spotted)

Trait/Grazing	(1) N	$\mu \pm s_\mu$	(2) N	$\mu \pm s_\mu$	(3) N	$\mu \pm s_\mu$
Age at 1st calving (d[2])	15,628	907.2 ± 1.1^A	11,894	942.3±1.3^B	2,889	970.4±2.2^C
Age at culling (d[2])	15,628	2,100.0 ± 7.9^A	11,894	2,153.4±9.4^B	2,889	2,219.6±16.4^C
Productive life (d[2])	15,628	1,178.4 ± 7.9^A	11,894	1,231.8±9.4^B	2,889	1,298.0±16.4^C
Number of lactations	15,628	3.22 ± 0.02^A	11,894	3.31 ± 0.02^B	2,889	3.46 ± 0.04^C
Lifetime milk yield (d[2])	15,577	18,237.2 ± 129.1^A	11,862	17,221.2 ± 153.6^B	2,878	15,359.3 ± 266,5^C
305-d[1] milk yield (kg)	13,551	5,985.3 ± 13.0^A	10,332	5,499.0 ± 15.6^B	2,462	4,709.6 ± 27.2^C
Milk/d[1] of life (kg)	15,677	7.73 ± 0.04^A	11,862	7.10 ± 0.04^B	2,878	6.08 ± 0.07^C
Milk/d[1] of prod. life (kg)	15,677	15.29 ± 0.05^A	11,862	13.58 ± 0.05^B	2,878	11.65 ± 0.10^C

(1) cows not grazed; (2) cows seasonally grazed as heifers; (3) cows seasonally grazed throughout their entire life; [1] day; ^{ABC} means with different superscript differ at *P*<0.01

seasonally grazed either as heifers (7,597.2±25.4 kg) or throughout their entire life (6,878.5±29.7 kg). As a result of longer productive life and 305-day milk yield, lifetime milk yield appeared significantly higher (18,408.5±59.4 vs. 15,869.2±185.7 and 14,549.6±24.7 kg) in cows not grazed. It is possible that in herds where cows were grazed as heifers, their diet after the first parturition contained more grass forage and less maize silage and concentrates than in herds where cows as heifers were not grazed. This could be a reason why lifetime milk production was significantly lower in cows of group (2) when comparing with cows of group (1). Consequently, cows of group (1) had milk yield per day of life (9.60±0.02 kg) and milk yield per day of productive life (20.13±0.03 kg) significantly higher than cows seasonally grazed either as heifers (8.63±0.06 and 18.83±0.08 kg) or throughout their entire life (7.90±0.09 and 17.27±0.10 kg). The findings contradict findings of Krogmeier et al. (2015) and Fuerst-Waltl et al. (2019) for Fleckvieh breed. These authors revealed better traits in cows seasonally grazed. Kučević et al. (2020) reported similar lifetime milk yield for Holstein cows in Serbia (2% difference in favour of Holstein cows not grazed in Slovakia).

The lifetime performance traits in Slovak Spotted breed showed similar pattern to Holstein breed. The highest values were found in group (1) in comparison to groups (2) and (3): 18,237.2±129.1 vs. 17,221.2±153.6 and 15,359.3±266.5 kg (lifetime milk yield), 5,985.3±13.0 vs. 5,449.0±15.6 and 4,709.6±27.2 kg (305-day milk yield), 7.73±0.04 vs. 7.10±0.04 and 6.08±0.07 kg (milk yield per day of life) and 15.29±0.05 vs. 13.58±0.05 and 11.65±0.10 kg (milk yield per day of productive life). With length of productive life almost two times shorter in comparison with Karan Fries cows in Iran (Dash et al., 2018), higher lifetime milk yield (by 15%) was found in Slovak Spotted cows. Krogmeier et al. (2015) reported higher lifetime milk yield (by 13%) for cows grazed on Alpine pastures when comparing to cows not grazed. This was not found for Slovak Spotted cows; it is probably a result of different pasture quality and different precipitation intensity between the Alps and Slovakia. The quality of pasture is hardly possible to be compared to quality of mixed ration, and vice versa, milk nutritional quality of grazing animals differs from that of non-grazing animals as reported by Lindmark Månsson (2008), Blaško et al. (2010) and Rolinec et al. (2018a, 2018b).

The estimates of least square means and their standard errors for longevity traits in dependence on year of culling are given in tables 3a (Holstein) and 3b (Slovak Spotted). The age at first calving significantly decreased from 869.7±1.2 to 804.8±0.9 days in Holstein cows (by 64.9 days). With the decrease in age at first calving, age at culling increased significantly from 1,525.8±9.4 to 1,734.3±6.8 days (by 208.5 days) between 2006 and 2019 with exception of change between years 2006 and 2007 when a temporary decrease in age at culling was observed. The decrease in age at first calving was also reported for Turkish Holstein cows by Teke and Murat (2013), although it was lower than in Slovak Holstein cows (about 90 days between 1997 and 2011). The length of productive life and number of lactations increased by 228.6 days (from 710.4±9.1 to 939.0±6.8 days) and by 0.52 lactation (from 2.06±0.02 to 2.58±0.01 lactation). Holstein cows in Slovakia had similar length of productive life as Holstein cows in Iran (Nilforooshan and Edriss, 2004) and lower than Holstein cows in Poland (Sawa and Bogucki, 2010). The age at first calving decreased even more (by 80.3 days) from 977.3±2.8 to 897.0±2.3 days in Slovak Spotted cows. Non-significant changes of age at culling, length of productive life and number of lactations between years were found. The decrease of age at first calving agreed with finding of Sawa and Bogucki (2010); it was roughly similar as for cows of the same breed in Romania and Slovenia (Cziszter et al., 2017 and Janžekovič et al., 2009). The length of productive life and its continuous decline are consistent with the results of Čanji et al. (2008) and Strapák et al. (2010).

The estimates of least square means and standard errors of means of lifetime milk performance traits in dependence on year of culling are given in tables 4a (Holstein) and 4b (Slovak Spotted). These traits significantly increased in both breeds. The lifetime milk yield increased almost two times from 11,745±223.7 to 22,135.4±162.8 kg (Holstein cows) and by one third from 14,406.4±344.6 to 20,419.3±286.8 kg (Slovak Spotted cows). Likewise, 305-day milk yield increased from 6,743.0±27.8 to 7,747.9±19.0 kg (Holstein) and from 4,542.0±34.5 to 5,853.8±27.8 kg (Slovak Spotted), milk yield per day of productive life increased from 6.75±0.08 to 11.29±0.06 kg (Holstein) and from 5.72±0.09 to 8.55±0.08 kg (Slovak Spotted); milk yield per day of life increased from 16.40±0.09 to 22.23±0.07kg (Hostein) and from 10.98±0.12 to 16.74±0.10 kg Slovak Spotted). Both 305-day milk yield and milk yield per day of life in Slovak Spotted cows were similar to these traits in Jersey cows (Boothby et al., 2020) and markedly higher than in Syrian Shami cows (Almasri et al., 2020). An increase of 305-day milk yield agreed with findings of Bujko et al. (2020) for cows of the same breed. With respect to tendency in shortening of productive life, the progress in lifetime milk performance traits is probably because of changed breeding strategies.

Table 3a. Least squares means and standard errors of longevity traits in dependence on year of culling (Holstein)

Factor/Trait Year of culling	N	Age at 1st calving (days) $\mu \pm s_\mu$	Age at culling (days) $\mu \pm s_\mu$	Productive life (days) $\mu \pm s_\mu$	Number of lactations $\mu \pm s_\mu$
2006	5,660	869.7 ± 1.2^{AB}	$1,525.8 \pm 9.4^{ABCD}$	730.5 ± 9.4^{ABCD}	2.10 ± 0.02^{ABCDE}
2007	6,254	863.0 ± 1.2^{ABCD}	$1,505.7 \pm 9.1^{ABCD}$	710.4 ± 9.1^{ABCD}	2.06 ± 0.02^{ABCDE}
2008	7,376	859.6 ± 1.1^{CDE}	$1,536.3 \pm 8.5^{BCDE}$	741.0 ± 8.5^{CDE}	2.08 ± 0.02^{CDE}
2009	9,506	857.5 ± 1.0^{DE}	$1,545.0 \pm 7.7^{DE}$	749.6 ± 7.7^{DE}	2.10 ± 0.02^{DE}
2010	9,396	854.8 ± 1.0^{EF}	$1,575.8 \pm 7.7^{EF}$	780.5 ± 7.7^{EF}	2.16 ± 0.02^{EF}
2011	9,510	851.1 ± 1.0^{FG}	$1,617.3 \pm 7.6^{FGH}$	822.0 ± 7.6^{FGH}	2.23 ± 0.02^{FG}
2012	10,766	846.5 ± 1.0^{GH}	$1,631.8 \pm 7.3^{GH}$	836.5 ± 7.3^{GH}	2.28 ± 0.02^{GHI}
2013	12,072	843.6 ± 0.9^{H}	$1,655.5 \pm 7.0^{HIJ}$	860.2 ± 7.0^{HIJ}	2.32 ± 0.01^{HI}
2014	11,344	836.3 ± 0.9^{I}	$1,675.9 \pm 7.1^{IJK}$	880.6 ± 7.1^{IJK}	2.34 ± 0.01^{IJ}
2015	11,743	829.9 ± 0.9^{J}	$1,684.9 \pm 7.0^{JK}$	889.6 ± 7.0^{JK}	2.41 ± 0.01^{JKLM}
2016	12,517	822.9 ± 0.9^{K}	$1,713.5 \pm 6.8^{KLMN}$	918.2 ± 6.8^{KLMN}	2.45 ± 0.01^{KLM}
2017	11,906	817.0 ± 0.9^{L}	$1,737.3 \pm 6.9^{LMN}$	942.0 ± 6.9^{LMN}	2.49 ± 0.01^{LM}
2018	12,788	810.0 ± 0.9^{M}	$1,725.6 \pm 6.8^{MN}$	930.3 ± 6.8^{MN}	2.49 ± 0.01^{M}
2019	12,728	804.8 ± 0.9^{N}	$1,734.3 \pm 6.8^{N}$	939.0 ± 6.8^{N}	2.58 ± 0.01^{N}

ABCDEFGHIJKLMN least squares means with different superscripts are significantly different at P<0.01

Table 3b. Least squares means and standard errors of longevity traits in dependence on year of culling (Slovak Spotted)

Factor/Trait Year of culling	N	Age at 1st calving (days) $\mu \pm s_\mu$	Age at culling (days) $\mu \pm s_\mu$	Productive life (days) $\mu \pm s_\mu$	Number of lactations $\mu \pm s_\mu$
2006	1,611	977.3 ± 2.8^{ABC}	2,207.4 ± 21.2	1,285.8 ± 21.2	3.43 ± 0.05
2007	1,678	967.8 ± 2.8^{ABCDE}	2,157.2 ± 20.6	1,235.6 ± 20.4	3.32 ± 0.05
2008	1,880	965.6 ± 2.6^{CDEF}	2,175.1 ± 19.6	1,253.5 ± 19.6	3.32 ± 0.05
2009	2,257	956.1 ± 2.4^{DEFGH}	2,102.4 ± 18.0	1,180.8 ± 18.0	3.20 ± 0.05
2010	2,067	953.8 ± 2.5^{EFGHI}	2,144.5 ± 18.5	1,222.9 ± 18.5	3.23 ± 0.05
2011	2,159	949.9 ± 2.4^{FGHI}	2,111.9 ± 18.2	1,190.8 ± 18.2	3.18 ± 0.04
2012	2,250	942.1 ± 2.4^{GHIJ}	2,187.0 ± 17.8	1,265.4 ± 17.8	3.37 ± 0.04
2013	2,451	944.0 ± 2.3^{HI}	2,173.8 ± 17.1	1,252.2 ± 17.1	3.39 ± 0.04
2014	2,293	938.1 ± 2.4^{IJ}	2,189.3 ± 17.8	1,267.7 ± 17.8	3.39 ± 0.04
2015	2,442	927.5 ± 2.3^{JKL}	2,150.3 ± 17.2	1,228.7 ± 17.2	3.39 ± 0.04
2016	2,350	919.5 ± 2.4^{KLM}	2,187.2 ± 17.5	1,265.6 ± 17.5	3.41 ± 0.04
2017	2,123	914.1 ± 2.5^{LM}	2,147.5 ± 18.3	1,225.9 ± 18.3	3.31 ± 0.04
2018	2,384	906.8 ± 2.3^{MN}	2,161.2 ± 17.4	1,239.6 ± 17.4	3.37 ± 0.04
2019	2,466	897.0 ± 2.3^{N}	2,112.7 ± 17.3	1,191.1 ± 17.3	3.32 ± 0.04

ABCDEFGHIJKLMN least squares means with different superscripts are significantly different at P<0.01

Table 4a. Least squares means and standard errors of lifetime milk traits in dependence on year of culling (Holstein)

Factor/Trait Year of culling	N	Lifetime milk yield (kg) $\mu \pm s_\mu$	305-day milk yield (kg) $\mu \pm s_\mu$	Milk/day of life (kg) $\mu \pm s_\mu$	Milk/day of life (kg) $\mu \pm s_\mu$
2006	5,660	11,745.1 ± 223.7^{AB}	6,743.0 ± 27.8^{A}	6.75 ± 0.08^{AB}	16.40 ± 0.09^{A}
2007	6,254	12,107.1 ± 215.2^{ABC}	6,980.6 ± 26.8^{B}	7.00 ± 0.07^{ABC}	17.11 ± 0.09^{BCDEF}
2008	7,376	12,984.5 ± 200.9^{CDE}	7,137.5 ± 24.9^{CDEF}	7.39 ± 0.07^{CDE}	17.29 ± 0.08^{CDEF}
2009	9,506	13,275.0 ± 183.9^{DE}	7,214.1 ± 22.8^{DEF}	7.49 ±0.06^{DE}	17.26 ± 0.08^{DEF}
2010	9,396	13,902.8 ± 183.4^{EF}	7,220.5 ± 22.6^{EF}	7.74 ± 0.06^{EF}	17.30 ± 0.08^{EF}
2011	9,510	14,774.1 ± 181.3^{FG}	7,208.7 ± 22.1^{F}	8.07 ± 0.06^{FG}	17.59 ± 0.08^{F}
2012	10,766	15,560.2 ± 173.3^{GH}	7,362.7 ± 21.1^{G}	8.39 ± 0.06^{GH}	18.15 ± 0.07^{G}
2013	12,072	16,421.7 ± 166.5^{H}	7,519.7 ± 20.3^{H}	8.70 ± 0.06^{H}	18.54 ± 0.07^{H}
2014	11,344	17,331.6 ± 169.5^{IJ}	7,642.0 ± 20.5^{I}	9.12 ± 0.06^{I}	19.03 ± 0.07^{I}
2015	11,743	18,178.0 ± 166.9^{J}	7,777.6 ± 20.2^{J}	9.49 ± 0.06^{J}	19.81 ± 0.07^{J}
2016	12,517	19,140.0 ± 161.8^{KL}	7,691.4 ±19.6^{K}	9.86 ± 0.06^{K}	20.20 ± 0.07^{KL}
2017	11,906	19,928.3 ± 164.2^{LM}	8,084.2 ± 19.7^{L}	10.18 ± 0.06^{LM}	20.43 ± 0.07^{L}
2018	12,788	20,370.0 ± 160.7^{M}	8,310.4 ± 19.3^{M}	10.48 ± 0.06^{M}	21.11 ± 0.07^{M}
2019	12,728	22,135.4 ± 162.8^{N}	7,747.9 ± 19.0^{N}	11.29 ± 0.06^{N}	22.23 ± 0.07^{N}

^{ABCDEFGHIJKLMN} least squares means with different superscripts are significantly different at P<0.01

Table 4b. Least squares means and standard errors of lifetime milk traits in dependence on year of culling (Slovak Spotted)

Factor/Trait Year of culling	N	Lifetime milk yield (kg) $\mu \pm s_\mu$	305-day milk yield (kg) $\mu \pm s_\mu$	Milk/day of life (kg) $\mu \pm s_\mu$	Number of lactations $\mu \pm s_\mu$
2006	1,611	14,406.3 ± 344.6^{ABCDEF}	4,542.0 ± 34.5^{AB}	5.72 ± 0.09^{ABCDEF}	10.98 ± 0.12^{AB}
2007	1,678	14,370.4 ± 335.4^{ABCDEF}	4,741.3 ± 34.0^{AB}	5.84 ± 0.09^{ABCDEF}	11.40 ± 0.12^{ABC}
2008	1,880	15,313.9 ± 318.1^{CDEFGH}	4,960.6 ± 32.4^{CDEF}	6.16 ± 0.09^{CDF}	11.94 ± 0.11^{BCDEF}
2009	2,257	14,636.0 ± 291.7^{DEF}	5,087.4 ± 30.0^{DEFG}	6.04 ± 0.08^{DEF}	12.29 ± 0.10^{DEF}
2010	2,067	15,238.6 ± 300.7^{EFG}	5,077.1 ± 30.5^{EFG}	6.30 ± 0.08^{EF}	12.17 ± 0.11^{EF}
2011	2,159	14,799.7 ± 294.9^{FG}	4,985.1 ± 30.0^{F}	6.17 ± 0.08^{F}	11.98 ± 0.11^{F}
2012	2,250	16,609.6 ± 289.2^{GHIJ}	5,189.6 ± 29.0^{G}	6.84 ± 0.08^{GHI}	12.96 ± 0.10^{GH}
2013	2,451	17,143.8 ± 278.3^{HIJL}	5,403.0 ± 28.0^{H}	7.04 ± 0.08^{HIJ}	13.48 ± 0.10^{HI}
2014	2,293	17,953.4 ± 288.4^{IJKL}	5,623.3 ± 29.2^{IJ}	7.30 ± 0.08^{IJ}	13.85 ± 0.10^{I}
2015	2,442	18,110.9 ± 279.3^{JKL}	5,751.5 ± 28.3^{J}	7.50 ± 0.08^{JKL}	14.80 ± 0.10^{JKL}
2016	2,350	19,390.4 ± 283.7 ^{KLMN}	5,999.0 ± 28.4^{KLN}	7.97 ± 0.08^{KLM}	15.28 ± 0.10^{KL}
2017	2,123	18,821.5 ± 297.1^{LMN}	6,054.2 ± 29.8^{L}	7.86 ± 0.08^{LM}	15.20 ± 0.11^{L}
2018	2,384	19,935.5 ± 282.9^{MN}	6,303.8 ± 28.4^{M}	8.27 ± 0.08^{MN}	15.98 ± 0.10^{M}
2019	2,466	20,419.3 ± 286.8^{N}	5,853.8 ± 27.8^{N}	8.55 ± 0.08^{N}	16.74 ± 0.10^{N}

^{ABCDEFGHIJKLMN} least squares means with different superscripts are significantly different at P<0.01

CONCLUSIONS

The findings illustrate that longevity and lifetime performance traits reflect the complex influence of various factors affecting their variation. Some inconsistent results between breeds were noted. As expected, the values for lifetime milk performance traits were the highest in cows not grazed (regardless of breed). In Holstein breed, better longevity traits were found in cows not grazed; not as expected. In Slovak Spotted breed, better longevity traits were found in cows with access to seasonal grazing; as expected.

Over time, significant increases of longevity (except for age at first calving) and lifetime milk performance traits were found in Holstein cows. Despite the significant decrease in age at first calving in Slovak Spotted cows, no significant changes were observed in other longevity traits in this breed. Significant increases of lifetime milk performance traits over time were found in both Holstein and Slovak Spotted cows.

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