

ASSOCIATION BETWEEN AGE AT FIRST CALVING AND MILK PRODUCTION IN FIRST LACTATION ON LONGEVITY TRAITS IN HOLSTEIN COWS

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Abstract: The objective of this research was to determine the association between age at first calving (AFC) and milk production in the first lactation of longevity traits for Holstein cows. The research was conducted on 2307 cows raised on 4 farms in AP Vojvodina. The cows were culled in the period from 2017 to 2018. The cows belonged to the group of Holstein Friesian breed of cattle. Cow longevity was observed using three parameters: number of lactations (NL), lifetime milk yield (LMY) and length of productive life (LPL). The research involved the influence of the farm on which the animals realized their production, the season of first calving. A mean value obtained for the length of productive life in the analysed population was 1207 days (3.30 years on average). During this period the animals on average realized 2.45 lactations and produced on average 18798 kg milk. All studied traits showed a high level of variability. From these data, the study sought to determine the influence of factors on the traits of longevity, our research present that studied factors showed high statistical significance on these traits except in the case of the season of first calving where a statistical significance effect wasn't observed. The season of first calving did not affect the animal traits for longevity and, generally, didn't affect the calving interval. Regarding the obtained correlation data between age at first calving and length of productive life, it can be concluded that belated AFC leads to reduced reproductive performance.

Key words: Age at first calving, longevity, Holstein, milk yield in first lactation

Introduction

There are many factors affecting profitability in dairy production, one of the most important factors is longevity. Increased longevity reduces the direct costs of raising or replacement increases in total profit. Age at first calving (AFC),

calving intervals, length of each lactation and success in surviving to another lactation are effective on longevity (*Van-Raden and Klaaskate, 1993; Gröhn and Rajala-Schultz, 2000*). An important factor in the cost of raising dairy replacements is AFC in these factors. Reproductive traits, such as AFC and calving interval (CI) affect economically important traits like longevity, productive life and profitability of cows (*Do et al., 2013; Singh et al., 2017*). Longevity is one of the most important traits in dairy cow breeding. There are strong correlations between cow reproductive traits, in this case, age at first calving have significant influence of the length of CI not only in first, but also in later lactations (*Janžekovič et al., 2009*). Age at first calving not only has strong coherence with cow longevity but also can affect the future reproductive performance (*Nilforooshan and Edriss, 2004; Riecka and Candrák, 2011*).

In the previous studies, it was determined that the optimal first calving age for reaching maximal lifetime and daily production level and also for keeping cows in herds for as long as possible, is 24 – 27 months (*Pirlo et al., 2000; Brickell et al., 2009*). *Nilforooshan and Edriss (2004)* stated that the AFC of 24 months was optimal for lifetime milk production. The higher values of AFC are associated with poorer fertility in the first lactation and the shorter LPL of the cow (*Zavadišilová and Štípková 2013*). The first calving between 22 and 26 months maximized the number of lactations and the number of lactation days in an animal's life (*Froidmont et al., 2013*). *Pirlo et al. (2000)* found that there were small differences in the longevity of cows when the AFC ranged between 671 (22.4 months) and - 823 days (27.4 months).

The objective of this study was to estimate association between age at first calving and milk production in first lactation on longevity traits, using three parameters such as number of lactations (NL), lifetime milk yield (LMY) and length of productive life (LPL) for longevity in Holstein cows of the Vojvodina Province, Serbia.

Materials and Methods

A research was conducted on the animals raised on 4 farms in AP Vojvodina. Trial included 2307 cows culled in the period from 2017 to 2018. The cows belonged to the group of Holstein Friesian breed of cattle. Longevity in cows was observed using three parameters: number of lactations (NL), lifetime milk yield (LMY) and length of productive life (LPL). Length of productive life is defined as a time period starting from the date of the first calving up to the date of culling. Lifetime milk yield (LMY) was calculated using the data of individual milk recordings in different lactations.

Cows were housed in two types of housing systems (free-stall and tie-stall dairy barns) in 4 dairy farms with different sizes.

To study the effect of AFC, cows were classified in 7 groups: (group I – from 20 to 22 months of age, group II – from 22 to 24 months of age, group III – from 24 to 26 months of age, group IV – from 26 to 28 months of age, group V – from 28 to 30 months of age, group VI – from 30 to 32 months of age, group VII – from 32 to 34 months of age).

Season of calving was split into 4 seasons according to the local environmental conditions (1st: December-February; 2nd: Mart-May; 3rd: June-August and 4th: September-November). Feeding of cows included maize silage, lucerne hay and concentrate feed along with mineral supplements. The diet formulation was according to the milk production of cows.

The study included the effect of the farm on which the animal realized its production, age at first calving and the season of first calving of longevity and calving interval using of a following linear model:

$$Y_{ijkl} = \mu + F_i + AFC_j + S_k + SEZ_l + e_{ijkl}$$

Where:

Y_{ijkl} - phenotypic manifestation of a studied

trait, μ - population general average,

F_i - fixed effect of i farm ($i=1,2,3,4$),

S_k - fixed effect of system of rearing ($k=1$ -free stall barn, 2 -tied housing

system), SEZ_l - fixed effect of the season of first calving ($l=1-4$), e_{ijkl} - random error.

The average values and variability of examined traits as well as the effect of factors on these traits were studied by means of the procedures PROC UNIVARIATE and PROC GLM within SAS software package (SAS 9.3, 2012). The relationship between the examined traits was determined using the PROC CORR procedure within the same software program package.

Results and Discussion

Table 1 shows the statistical indicators of the analyzed traits. A productive life in the analysed population was 1207 days (3.30 years on average). During this period the animals realized 2.45 lactations and produced 18798 kg of milk on average. The average value for length of productive life (LPL) in research was (1207 days / 3.30 years) higher in relation to the value obtained by *Stanojević et al. (2015)* in the Serbian group of Black and White cattle improved by Holstein (3.14 years). Determined average value for length of productive life is lower in relation to the value obtained by *Jenko et al. (2015)* in the population of Slovenian Brown cattle breed (1544 days). The average number of lactations (NL) obtained from the current study (2.45) was relatively similar (2.64) with the results by *Stanojević et al. (2015)*. The number of lactations (Table 1) was lower (2.45) than the average of 2.94 noted by *Hare et al. (2006)* in the United States between 1980 and 1994.

Table 1. Phenotypic manifestation and variability of the analysed traits

Traits	n	\bar{X}	SD	CV (%)	min	max
LPL	2307	1207	425	35	162	2287
NL	2307	2.45	1.1	45	1	6
LMY	2307	18798	12021	64	306	79367
MY ₁ L	2307	6427	874	13.6	4867	8379
CI	2307	438	65	14.8	347	580
AFC	2307	26.92	3.90	14.4	17.4	41.2

LPL - length of productive life (day), NL - number of lactation, LMY - lifetime milk yield (kg), MY₁L - milk yield in 1st lactation (kg), CI₁- length of calving interval among 1st and 2nd lactation (day), AFC - age at 1st calving (mo).

Obtained results for the AFC were 26.92 mo which is in accordance with those reported by *Nilforooshan and Edriss (2004)*, 26.84 months on average. In Table 1 is showed on average that cows were produced 6427 kg in the first lactation (MY₁L) which is in accordance with results obtained by *Kučević et al. (2019)*. Lower values in research by *Teke and Murat (2013)* for the population of Turkish Holsteins of the Mediterranean region in Turkey was established for a mean of milk yield in first lactation (5541 kg). Mean age at first calving of this population (26.92 mo) was less than the estimated mean of 29.81 mo in Turkey (*Teke and Murat, 2013*).

The research also included the analysis of the effect of farm on which the animals realized its production, the AFC, a season of 1st calving and the system of rearing on longevity. The values of F-test and their significance are shown in Table 1. The season of first calving did not affect the animal traits for longevity and, generally, didn't affect the calving interval. Similar results in their research paper published *Froidmont et al. (2012)* who established that season at first calving did not affect the animal's longevity and generally had a very little effect on the calving interval, number of lactations or average lactation length.

Table 2. Effect of fixed factors on length of productive life, number of lactations, lifetime milk yield and length of calving interval

Traits	Farm	Season of 1 st calving	System of rearing	AFC
LPL	8.96 [*]	0.16 ^{ns}	0.77 ^{ns}	117.60 ^{**}
NL	16.46 ^{**}	0.01 ^{ns}	1.73 ^{ns}	92.30 ^{**}
LMY	5.06 [*]	0.1 ^{ns}	7.78 ^{**}	1.68 ^{ns}
CI	16.46 ^{**}	0.01 ^{ns}	1.73 ^{ns}	92.27 ^{**}

LPL - length of productive life, NL - number of lactation, LMY - lifetime milk yield; CI - length of calving interval between 1st and 2nd lactation; ns - no statistically significant effect, ($P > 0.05$)
^{*} - statistically high significant effect, ($0.05 > P > 0.01$); ^{**} - statistically very high significant effect, ($P < 0.01$).

Age at first calving has a significant effect ($P < 0.01$) for the length of productive life, a number of lactations but no significant effect for the lifetime milk yield ($P > 0.05$). Age at first calving significantly determines the length of the calving interval ($P < 0.01$). As age at first calving increases, also does length of calving interval in first and later lactations. Two types of housing systems showed no significant effect on length of productive life, a number of lactations and calving interval between 1st and 2nd lactation ($P > 0.05$), except the lifetime milk yield ($P < 0.01$). Results in the present study are consistent with other reports (Stanojević *et al.*, 2015; Kučević *et al.*, 2019; Nilforooshan and Edriss, 2004; Teke and Murat, 2013; Janžekovič *et al.* 2009).

The relationship between the examined traits such as length of productive life, number of lactations, lifetime milk yield and age of first calving of Holstein cows are given in Table 3.

Table 3. The relationship between the examined traits

Traits	AFC	MY _{1L}
LPL	-0.23 ^{**}	0.0023 ^{ns}
NL	-0.027 ^{ns}	0.0091 ^{ns}
LMY	-0.025 ^{ns}	-0.088 ^{ns}

ns - no statistically significant effect, ($P > 0.05$); ^{*} - statistically high significant effect, ($0.05 > P > 0.01$); ^{**} - statistically very high significant effect, ($P < 0.01$)

Values of the correlation between examined traits were low and did not have statistical significance ($P > 0.05$), except in the case of correlation between the length of productive life and age at first calving which was weak negative (-0.23) and statistically significant. This indicates that animals which were calved later had a shorter productive life. According to that, as age at first calving increased, productive life decreased. This trend shows the importance of reducing the age at first calving, which is supported by the negative phenotypic correlation between age at first calving and productive life obtained in a study by *Nilforooshan and Edriss (2004)*.

In the study from *Teke and Murat (2013)*, there was a slight positive correlation between the AFC and first lactation milk yield. *Moore et al. (1991)* and *Pirlo et al. (2000)*, reported a positive effect of increasing age at first calving on milk yield and our results were in contrast to the results of their studies.

Bewley et al. (2001) reported a negative effect of increasing age at first calving on milk yield. They also reported that a 1-month increase in average age at first calving was associated with 102.5 kg reduction in milk yield. Also, the results obtained by *Zavadilová and Štípková (2013)*, indicated that high age at first calving is related to a shortened length of productive life which confirmed our result in this case.

Conclusion

The age of first calving is one of the most important factors that have a significant impact on cow productivity in different lactations and its whole cow's life. Results from this study confirm that age at first calving can significantly affect length of productive life, number of lactations and length of calving interval. As age at first calving increases, also does calving interval in first and later lactations. Correlation between the length of productive life and age at first calving was weak negative (-0.23) and statistically significant so according to that, as age at first calving increased, productive life decreased. It can be concluded that belated AFC leads to reduced reproductive performance and it is one of the main reasons for reduced longevity.

Povezanost između uzrasta pri prvom teljenju i proizvodnje u prvoj laktaciji sa osobinama dugovečnosti kod mlečnih krava

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Rezime

Sprovedeno istraživanje imalo je za cilj da utvrdi povezanost između uzrasta pri prvom teljenju i proizvodnje mleka u prvoj laktaciji sa osobinama dugovečnosti za krave holštajn-frizijske rase. Istraživanjem je obuhvaćeno 2307 krava, sa 4 različite farme sa teritorije AP Vojvodine. Krave su izlučene u periodu od 2017 do 2018 godine. Dugovečnost krava je posmatrana kroz tri pokazatelja: broj ostvarenih laktacija (NL), životna količina proizvedenog mleka (LMY) i dužina produktivnog života (LPL). Prosečno trajanje produktivnog života za sva grla uključena u analizu iznosilo je 1207 dana (3.30 godine u proseku). Grla obuhvaćena analizom u toku svog produktivnog života su prosečno proizvela 18798 kg mleka. Broj laktacija koje je svako grlo prosečno ostvarilo u toku trajanja svog produktivnog života iznosio je 2.45, pri čemu su svi ispitani parametri pokazali visok nivo varijabilnosti. U istraživanju su ispitani fiksni uticaji farme na kojoj je grlo proizvodilo, uzrasta pri prvom teljenju, sistema proizvodnje i sezone pri prvom teljenju na osobine dugovečnosti i međutelidbeni interval, korišćenjem linearnog modela. Na osnovu rezultata dobijenih istraživanjem, fiksni faktori su pokazali visoku statističku značajnost za ispitivane osobine, osim u slučaju sezone pri prvom teljenju, gde nije ispoljena statistička značajnost za osobine obuhvaćene istraživanjem. Na osnovu rezultata, utvrđena je povezanost između uzrasta pri prvom teljenju i dužine produktivnog života, pri čemu se može zaključiti da su kraći produktivni život imale životinje koje su se kasnije telile.

Ključne reči: Uzrast pri prvom teljenju, dugovečnost, holštajn, proizvodnja mleka u prvoj laktaciji

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