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The impact of age at the first calving on lifetime milk yield, life span and herd life of dairy cows

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Abstract: *The impact of age at the first calving on lifetime milk yield, life span and herd life in dairy cows*. The increasing importance of functional traits (e.g. longevity) in cattle breeding is the result of their direct effect on profitability of production. The main objective of the study was to determine the influence of age of the first calving on lifetime milk yield, life span and herd life in Polish dairy cows. Cows were kept on farms with milk performance recording system. One-way analysis of variance was used to calculate the impact of age of the first calving on selected traits. Cows that first calving occurred at the age of 791–850 day achieved the highest lifetime milk, fat and protein yield per one day of life ($P \leq 0.01$). Moreover, their life span was also the longest ($P \leq 0.01$) and milk and protein yield per 1 day of utilization were the highest ($P \leq 0.01$). Obtained results suggest that the most favorable time of calving for dairy heifers is between 791–850 day of life. Therefore, milk producers should carefully consider the most suitable time of heifers insemination in order to achieve the most satisfying milk production.

Key words: age of the first calving, milk yield, herd life, dairy cows

INTRODUCTION

Short herd life is one of the most crucial issues for milk producers. Cows achieve their production peak during a period from second to forth lactation, therefore early culling (e.g. after second lactation) is unfavorable for farmers (Grodzki et al. 1998, Sawicka-Zugaj 2010, Frejlach et al. 2015). Results of Polish dairy cattle recording system of Polish Federation of Cattle Breeders and Dairy Farmers (PFHBIPM) for 2016 revealed that average herd life for Polish Holstein-Friesian (PHF) last only 3.05 years and for Simmental (SM) and Polish Black and White (ZB) breeds values were 3.31 and 5.09, respectively. Moreover, average herd life of a cow in Polish population was 3.03 years and it reflects in increased number of cows culled at age 5–6 years.

The estimation of selected indicators of milk performance in dairy herds is an important tool for evaluating the economics of production and the level of the breeding (Frejlach et al. 2015). According to Polish Federation of Cattle Breeders and Dairy Farmers data, production traits are still the most important part of PHF selection index. However, importance of functional traits (e.g. longevity or milking speed) has significant effect on profitability of production and increased interest from breeders (Visscher and Goddard 1995, Miglior et al. 2005, Frejlach et al. 2015).

Previous surveys carried out by different researchers suggest that the number of lactation may influence on cows yield and milk composition (Grodzki et al. 1998, Sawicka-Zugaj 2010, Frejlach et al. 2015). Moreover age of the first calving and the number of lactation can affect reproduction traits (Frejlach et al. 2015). Recently, Heise et al. (2018) presented analysis that suggest age of the first calving should be considered as another part of dairy cattle selection indexes, because it might remove functional genetic variance from survival traits.

The objective of the study was to estimate the influence of the age of first calving on lifetime milk yield, herd life and life span of dairy cows.

MATERIAL AND METHODS

Analyzed records were taken from SYMLEK database conducted by Polish Federation of Cattle Breeders and Dairy Farmers and referred to milk performance recordings of 1,563 dairy cows of Polish Holstein-Friesian breed maintained in Polish farms in 2016. Database contained information connected with milk, fat, protein yield, life span and herd life.

Statistical analysis were estimated using SPSS Imago 3 software. One-way analysis of variance was used to evaluate the impact of the age of first calving on the selected traits (life span, herd life and lifetime milk performance) by the following model:

$$Y_{ij} = \mu + A_i + e_{ij}$$

where:
Y_{ij} – value of the trait;
μ – general mean;
A_i – effect of i-th class of the age at first calving (i = 1–≤ 730; 2–731–790; 3–791–850; 4–851–910; 5–≥ 911);
e_{ij} – random error.

RESULTS AND DISCUSSION

An important factor that can influence cow yield is country of origin. In the study conducted by Czerniawska-Piątkowska et al. (2009) heifers imported from Germany achieved lower milk yield in 305 days lactation (8,400 kg) in comparison to native animals (8,463 kg). However, milk from imported cows had higher fat content. Similar results were presented by Kuczaj (2004). In his analysis cows imported from the Netherlands had lower yield and results were statistically significant. On the other hand, some authors suggest that imported cows had higher production than cows of Polish population (Skrzypek and Szukalski 2006). Therefore, differences in cows' production can be mainly the result of environmental conditions or nutrition but not necessary connected with animal genetic merit.

Cows that first calving occurred at the age of 791–850 (26–28 months) days achieved the highest ($P \leq 0.01$) lifetime milk, fat and protein yield (Table 1). Similar results were presented in the study carried out by Haworth et al. (2008) and Frejlach et al. (2015). In the survey presented by Haworth et al. (2008) most of the Australian Holstein heifers calved at the age of 750–850 days and their average lifetime milk yield was lower (18,415 l) than described in the paper. The age of first calving between 750––810 days was observed in dairy cows in analysis by Frejlach et al. (2015). They

TABLE 1. Lifetime milk, fat and protein yield of dairy cows according to age of first calving

Days	*N*	Lifetime milk yield (kg)		Lifetime fat yield (kg)		Lifetime protein yield (kg)	
		$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD*
≤ 730	275	16 932.4	1 346.83	737.3	58.73	582.5	45.59
731–790	439	19 023.5^{a}	1 178.50	790.0^{a}	51.39	635.5	39.89
791–850	380	19 044.6^{A}	1 446.68	790.7	63.09	641.0^{A}	48.97
851–910	255	17 265.3	1 396.15	719.4	60.89	590.1	47.26
≥ 911	244	17 180.0^{Aa}	1 318.67	733.6^{a}	57.51	590.3^{A}	44.63

Differences significant at $P \leq 0.01$ for A, A and $P \leq 0.05$ for a, a.

pointed out that the average age of calving for Holstein-Friesian breed was 772 days. Authors also suggested that heifers reached the highest milk yield per lactation (9,335 kg) if calved at the age of 821–880 days and calving at the age of ≥ 780 days resulted in milk production over 8,500 kg of milk.

The results obtained in this study showed that heifers that calved during 731–790 and 791–850 days of life had similar lifetime milk, fat and protein yield (no statistical differences were observed between those groups). However, in some countries, e.g. Italy or Iran authors suggested that the most favorable age of calving was 23–24 months (Pirlo et al. 2000, Nilforooshan and Edriss 2004). It is connected with profitability of production, but also with biological limitations of decreased age of first calving before 23rd month (Pirlo et al. 2000).

Cows that first calving occurred at the age of 791–850 days had longer life span than if calving occurred at the age of 851–910 days ($P \leq 0.01$) and also milk, fat and protein yield per 1 day of life were higher ($P \leq 0.01$) (Table 2). Cows with age of first calving during 791–859 days of life had also the longest herd life, however, no statistical differences were observed (Table 3). These animals had

TABLE 2. Average life span and milk, fat and protein yield per 1 day of life according to age of first calving in dairy cows

Days	*N*	Life span (days)		Milk yield per 1 day of life (kg)		Fat yield per 1 day of life (kg)		Protein yield per 1 day of life (kg)	
		$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD*
≤ 730	275	1 706.5^{ABC}	72.85	8.9^{AB}	0.33	0.38^{AB}	0.015	0.30^{aA}	0.011
731–790	439	1 875.7	63.74	9.1^{CD}	0.29	0.37^{aC}	0.013	0.30^{bB}	0.010
791–850	380	1 934.9^{A}	78.25	9.1^{EF}	0.36	0.38^{DE}	0.016	0.31^{cC}	0.012
851–910	255	1 924.5^{B}	75.52	8.2^{ACEa}	0.35	0.34^{AaD}	0.015	0.28^{abCd}	0.012
≥ 911	244	2 050.2^{C}	71.33	7.8^{BDFa}	0.33	0.33^{ACE}	0.015	0.27^{ABCd}	0.011

Differences significant at $P \leq 0.01$ for A, A and $P \leq 0.05$ for a, a.

TABLE 3. Average herd life and milk, fat and protein yield per 1 day of utilization according to age of first calving in dairy cows

Days	*N*	Herd life (days)		Milk yield per 1 day of utilization (kg)		Fat yield per 1 day of utilization (kg)		Protein yield per 1 day of utilization (kg)	
		$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD*
≤ 730	275	1 010.7	72.78	16.6a	0.42	0.71	0.018	0.56a	0.014
731–790	439	1 115.7	63.69	16.7	0.36	0.68	0.016	0.56	0.012
791–850	380	1 118.7	78.18	16.8^{abA}	0.45	0.70^{aA}	0.019	0.57^{aA}	0.015
851–910	255	1 045.7	75.45	16.2^{b}	0.43	0.67^{a}	0.019	0.55	0.015
≥ 911	244	1 099.6	71.26	15.7^{A}	0.41	0.67^{A}	0.018	0.54^{A}	0.014

Differences significant at $P \leq 0.01$ for A, A and $P \leq 0.05$ for a, a.

the highest milk and protein yield per 1 day of utilization ($P \leq 0.01$). Obtained results suggest that the most favorable time of calving for dairy cattle of PHF breed is between 791–850 days of heifers life.

Heise et al. (2018) presented data containing information that phenotypic correlations of age of first insemination, interval from first to last insemination, and age of first calving to survival during first lactation are negative. Mean estimated heritabilities in their study were 0.239 for age of first insemination, 0.007 for interval from first to last insemination, and 0.103 for age of first calving and 0.023 for survival till 49th day of first lactation, 0.016 for survival from 50th till 249th day of first lactation, and 0.028 for survival from 250th day of first lactation till second calving. The genetic correlation between the age of first insemination and interval from first to last insemination was close to zero (Heise et al. 2018). The importance of the age of the first calving was presented in previous studies (Ducrocq 2005, Sewalem et al. 2007, Sasaki et al. 2015, van Pelt et al. 2015) in which longevity was corrected for age of the first calving, either in the form of a covariate (Sewalem et al. 2007) or as a fixed class effect (Ducrocq 2005). In many countries, including Poland, that participate in Interbull genetic evaluations, longevity is corrected for age of the first calving in either form e.g. Canada, the Czech Republic, France, Germany, Great Britain, Israel, Italy, the Netherlands, the Republic of South Africa, Slovenia, Spain and Switzerland. Longevity is not corrected for the age of the first calving in Australia, Belgium, New Zealand and the USA (Heise et al. 2018).

According to Guliński et al. (2003), age of the first calving is one of the most important reproduction trait. In their study age of the first calving of cows from Polish population occurred earlier during both seasons – winter (802 days) and summer (807) comparing to cows imported from Germany (950 and 813 days, respectively). Results obtained by Sawicka-Zugaj (2000) reveled that the

average age of the first calving of cows imported from the Netherlands was 815 days. Guliński et al. (2003) also suggested that heifers that calved around 26th month of life achieved higher production in the first lactation in comparison to heifers that calved later than in 30th month of life.

Age of the first insemination, time from first to last (or successful) insemination, pregnancy length are functional traits. In previous studies these traits were shown to be heritable (Mäntysaari et al. 2002, Berry et al. 2003, Jamrozik et al. 2005, Liu et al. 2008, Norman et al. 2009). Especially, time from first to last insemination is a widely used reproduction trait and part of selection indexes in different countries, e.g. Germany (Heise et al. 2018). Therefore age of the first calving could be dissected into several separated traits, e.g. age of the first insemination, time from first to last insemination (Heise et al. 2018).

CONLUSIONS

The importance of functional traits, e.g. longevity or age of the first calving in cattle breeding increased, because these traits affect profitability of production. Obtained results revealed that if the first calving occurred at the age of 791–850 days cows had the highest lifetime milk, fat and protein yield. Moreover, their life span was also the longest and also milk and protein yield per 1 day of utilization were the highest. Cows with age of first calving during 791–850 days of life had also the longest herd life (no statistical differences were observed). Presented data suggest that the most favorable time of calving for dairy heifers is between 791 and 850 days of their life. Age of the first insemination and time from first to last insemination are important for cattle breeding. Therefore, producers should carefully consider the most suitable time of heifers insemination in order to achieve as satisfying as possible milk production

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Streszczenie: *Wpływ wieku pierwszego ocielenia na wydajność życiową, długość życia i użytkowania krów mlecznych.* Cechy funkcjonalne (np. długowieczność) mają coraz większe znaczenie w hodowli bydła, ponieważ wpływają bezpośrednio na opłacalność produkcji. Głównym celem analiz było określenie wpływu wieku pierwszego ocielenia na wydajność życiową, długość życia i użytkowania krów mlecznych w Polsce. Krowy utrzymywano w gospodarstwach objętych oceną użytkowości mlecznej. Wpływ wieku pierwszego

ocielenia na wybrane cechy oszacowano, wykorzystując jednoczynnikową analizę wariancji. Największą wydajność życiową mleka, tłuszczu i białka w przeliczeniu na 1 dzień życia osiągnęły krowy, które cieliły się w wieku 791–850 dni ($P \leq 0{,}01$). Ponadto były one również najdłużej użytkowane ($P \leq 0{,}01$) i osiągnęły największą wydajność mleka i białka w przeliczeniu na 1 dzień użytkowania ($P \leq 0{,}01$). Otrzymane wyniki sugerują, że wiek 791–850 dni jest najkorzystniejszym momentem wycielenia dla jałówek krów mlecznych. Z tego powodu producenci mleka powinni starannie rozważyć moment inseminacji jałówek, żeby osiągać jak najkorzystniejsze wyniki produkcyjne.

Słowa kluczowe: wiek pierwszego ocielenia, wydajność mleczna, długość użytkowania, krowy mleczne

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