

ASSOCIATION BETWEEN PRIMIPAROUS AND LIFETIME PERFORMANCE OF COWS

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ABSTRACT

Analyses were performed based on records from the SYMLEK database. Data on milk performance of 20 068 Polish Holstein-Friesian cows were accounted for. Productive and functional traits were analysed alongside culling reasons. The cows first calved at an average age of 807 days and primiparous milk yield averaged 6513 kg. The lifespan of cows ranged from 1830 to 3156 days depending on reasons for culling. Cows removed from the herd for old age had the longest lifespan, whereas the least productive animals sold for further breeding had the shortest lifespan. Cows with the longest productive life had an average lifetime yield of 40 000 kg milk. The coefficients of correlation between primiparous milk production and lifespan ranged from 0.30 (cows culled for old age, low milk production, and culled for sale) to 0.08 (cows culled for other reasons). The analysed population was characterized by high positive coefficients of correlation between first lactation yield and lifetime yield (0.34–0.64). In all the classes of cows accounting for culling reasons, positive correlations were estimated between primiparous milk yield and milk production per day of age and day of productive life.

Key words: cows, longevity, culling, milk yield

INTRODUCTION

Consistent breeding programmes have developed dairy cattle populations that differ considerably from those of 20–30 years ago in terms of productive and functional traits. In recent years, this has been accompanied by shorter productive life of dairy cows both in Poland and around the world. Dairy cows are unable to achieve longevity because they are culled before natural death. Longevity is considered the most important functional trait in dairy cattle, which is of key importance in terms of breeding and production [Strapák et al. 2005, Brickell et al. 2010, Litwińczuk et al. 2016]. Selection indices in many countries give longevity traits a weighting of 40–50%, because the length of productive life in dairy cows has a decisive effect on the profitability of milk production [Żukowski 2009]. According to Ziętara et al. [2013], the optimum milk production life should be 5–8 lactations, which is why the actual productive period of cows, which in recent years has been around 3 lactations [PFHBiPM 2016], must be considered too short. Research indicates that in the national population of cows, peak pro-

duction generally occurs at the third to fourth lactation. Therefore, early culling prevents the cows from achieving maximum production, which is economically unfavourable. The consequences of the shortened productive life and the need for rapid replacement of the herd also include the fact that selection of future dams is limited, which causes large economic losses [Strapák et al. 2005, Brickell et al. 2010]. An increase in length of productive life from 3 to at least 5 lactations would solve this problem and enable the number of reared heifers to be increased [Ziętara et al. 2013]. The rapid culling of cows motivates breeders to increase the milk yield of primiparous cows so as to compensate for herd replacement costs as soon as possible. While the first lactation should be considered as a test lactation because the cow's body is still developing. Thus, first lactation yield is of particular importance considering the many-year tendency to shorten the lifespan of cows [Sawa 2011].

Results concerning the relationship between first lactation milk production and subsequent lifetime performance are inconsistent. Besides, because animals are selected for the herd and culled on the basis of various

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criteria, it is difficult to find an optimal solution. Amin [2007] reported a positive genetic correlation between first lactation yield and length of productive life, whereas Łukaszewicz and Krencik [1994] found negative correlations between primiparous milk production and survival traits. Studies by Krencik and Łukaszewicz [1991] and Sawa and Bogucki [2010] indicate that milk production life depends on first lactation yield of the cows. Excessive milk yield of the primiparous cows was found to shorten the lifespan and milk production period of the cows. From this perspective, it is pertinent to determine how the use of the cow in a herd with a specific milk production level will influence the decision on when to first milk the cow as well as the cow's milk yield and fertility in the first production cycle. Of particular importance in terms of the lifetime performance is age at first calving, which should be neither early nor late. Research involving European and American populations of cattle indicate that currently the optimum age at first calving (for the HF breed) should be 24–25 months [Le Cozler et al. 2008, Wathes et al. 2014].

The objective of the present study was to estimate basic production and functional traits in a population of Polish Holstein-Friesian cows, and to determine the association of age at first calving and production level of primiparous cows with longevity and lifetime productivity traits, taking into account the reasons for culling the animals from the herd.

MATERIAL AND METHODS

The analyses were performed based on records from the SYMLEK database. Milk performance data of 20 068 Polish Holstein-Friesian cows, used in the years 2007–2015 in the Kujawsko-Pomorskie province (about 1600 herds), were included. Age at first calving and milk yield of primiparous cows were calculated. Analysis was made of longevity (lifespan and length of productive life), lifetime performance, milk production per day of productive life, and milk production per day of age. The following reasons for culling from the herd were included based on the SYMLEK system: sold for further breeding, low milk yield, udder diseases, infertility and reproductive disorders, infectious diseases (including leukemia), old age, metabolic and gastrointestinal diseases, respiratory diseases, locomotor diseases, accidents, and others). In the statistical analysis, the culling reasons were divided into three categories:

1. Old age,
2. Low milk yield, sold for further breeding,
3. Others (infertility, accidents, metabolic diseases, locomotor diseases, respiratory diseases, infectious diseases).

These culling categories were used to calculate the correlation coefficients of age at first calving and primiparous milk yield with longevity, lifetime performance, milk yield per day of productive life, and milk yield per day of age. Survival to the next lactation was also computed.

The data were statistically analysed using multifactorial analysis of variance (GLM procedure) and CORR procedure (SAS 2014).

RESULTS AND DISCUSSION

The results given in Table 1 show that the cows first calved at an average age of 807 days (26.9 months). Earlier studies [Nogalski 2004, Krężel-Czopek and Sawa 2008] suggest that the most appropriate age for first calving, with regard to lifetime daily milk production, is 22–26 months of age, which is earlier than for the population studied here. However, the first study cited above concerned imported animals and did not account for the entire population and the entire productive period. Nevertheless, it was found that age at first calving has a negative effect on lifetime performance parameters of the cows (including milk yield per day of age and milk yield per day of rearing) only after age at first calving exceeds 28 months.

The mean yield of primiparous cows was 6513 kg of milk. Depending on the reasons for culling, the average lifespan of the cows ranged from 1830 days (5.01 years) to 3156 days (8.64 years). The cows removed from the herds for old age had the longest lifespan, and the least productive animals sold for further breeding had the shortest lifespan (probably also largely because they failed to meet breeders' expectations regarding the productivity). The lifetime of the cows culled from the herds for other reasons, was 2109 days (5.77 years).

Also earlier studies conducted in high-producing herds and large populations showed that cows culled for low milk yield had the shortest lifespan [Pawlina et al. 1997, Sawa and Bogucki 2010].

The longevity of the analysed population of cows improved in relation to the results reported by Sawa and Bogucki [2010] for cows that first calved in 1988. The longer productive life of the cows results, among others, from the shortening of their rearing period.

The lifespan and thus the length of productive life of the cows is strictly related to their lifetime productivity. Our analyses showed that cows with the longest productive life achieved the mean lifetime yield of 40 000 kg milk. Almost three times as little milk (14 526 kg on average) was obtained from the cows culled for low yield and those sold before the end of their productive lives. In the group of cows removed from the herd for other reasons, the lifetime productivity yield was 21 249 kg of milk.

As reported by Wangler [2006], production efficiency of cows depends not only on their lifetime performance and productive life, but also on their milk yield per unit of time. Therefore, the appropriate parameters are milk yield per day of productive life or milk yield per day of age. Determining the milk yield per day of age is particularly important for farms breeding their own stock to estimate milk production profitability, because it determines the costs of rearing.

Cows with the longest productive life were characterized by the highest values of milk production per day of productive life and per day of age – 16.9 and 11.9 kg, respectively. Lower values of these parameters were noted in the group of cows removed from the herd for other reasons (16.5 and 9.1 kg), and the lowest in cows which were culled due to low milk yield and culled for sale (14.2 and 7.1 kg).

Based on a study of the German dairy cattle population, Wangler [2006] considered cows yielding more than 15 kg of milk per day as profitable. In our study, this condition is met by the cows culled for old age and those culled for other reasons. However, we should also remember to consider the economic circumstances (milk price) as well as the high daily milk production per lactation along with good cytological quality of the milk.

Table 2 provides data on survival of the cows to the next lactation. Analysis showed that 95.3% of the cows entered their second lactation. In the subsequent lactations, culling rate was markedly higher at approximately 20%. It should be noted that less than 30% of the foundation herd animals went into the fifth lactation. In the study of Reklewski et al. [2004], survival of cows to the second lactation was lower at 75%. In turn, Sherwin et al. [2016] reported the culling rate of primiparous cows to be

Table 1. Basic statistics for productive and functional traits in the analysed cow population

Tabela 1. Podstawowa statystyka cech produkcyjnych i funkcjonalnych analizowanej populacji krów

Trait – Cecha	N	LSM	SE
Age at first calving, days Wiek pierwszego wycielenia, dni	20 068	807	109
Milk yield of primiparous cows, kg Wydajność pierwiastek, kg	20 068	6513	2571
Lifespan of cows culled for old age, days Długość życia krów wybrakowanych z powodu starości, dni	297	3156	862
Lifespan of cows culled for sale and culled for low milk yield, days Długość życia krów wybrakowanych z powodu sprzedaży i niskiej wydajności, dni	3099	1830	637
Lifespan of cows culled for other reasons, days Długość życia krów wybrakowanych z pozostałych przyczyn, dni	16 672	2109	733
Productive lifespan of cows culled for old age, days Długość życia produkcyjnego krów wybrakowanych z powodu starości, dni	297	2321	489
Productive lifespan of cows culled for sale and culled for low milk yield, days Długość życia produkcyjnego krów wybrakowanych z powodu sprzedaży i niskiej wydajności, dni	3099	995	434
Productive lifespan of cows culled for other reasons, days Długość życia produkcyjnego krów wybrakowanych z pozostałych przyczyn, dni	16 672	1274	515
Lifetime milk yield of cows culled for old age, kg Wydajność życiowa krów wybrakowanych z powodu starości, kg	297	39 964	18 005
Lifetime milk yield of cows culled for sale and culled for low milk yield, kg Wydajność życiowa krów wybrakowanych z powodu sprzedaży i niskiej wydajności, kg	3099	14 526	10 997
Lifetime milk yield of cows culled for other reasons, kg Wydajność życiowa krów wybrakowanych z pozostałych przyczyn, kg	16 672	21 249	14 025
Milk yield per day of productive life of the cows culled for old age, kg Wydajność na dzień życia produkcyjnego krów wybrakowanych z powodu starości, kg	297	16.9	4.3
Milk yield per day of productive life of the cows culled for sale and culled for low milk yield, kg Wydajność na dzień życia produkcyjnego krów wybrakowanych z powodu sprzedaży i niskiej wydajności, kg	3099	14.2	4.2
Milk yield per day of productive life of the cows culled for other reasons, kg Wydajność na dzień życia produkcyjnego krów wybrakowanych z pozostałych przyczyn, kg	16 672	16.5	4.7
Milk yield per day of age of the cows culled for old age, kg Wydajność na dzień życia krów wybrakowanych z powodu starości, kg	297	11.9	4.3
Milk yield per day of age of the cows culled for sale and culled for low milk yield, kg Wydajność na dzień życia krów wybrakowanych z powodu sprzedaży i niskiej wydajności, kg	3099	7.1	3.4
Milk yield per day of age of the cows culled for other reasons, kg Wydajność na dzień życia krów wybrakowanych z pozostałych przyczyn, kg	16 672	9.1	4.0

Table 2. Survival of cows to the next lactation

Tabela 2. Przeżywalność krów do kolejnych laktacji

Next lactation Kolejna laktacja	Number of cows Liczba krów	Survival to the next lactation, % Przeżywalność do kolejnych laktacji, %
1	20 068	100.0
2	19 125	95.3
3	14 469	72.1
4	10 475	52.2
5	5879	29.3
6	1705	8.5
7	522	2.6
8	100	0.5

Table 3. Correlation coefficients of age at first calving and primiparous milk yield with lifespan of cows

Tabela 3. Współczynniki korelacji między wiekiem pierwszego wycielenia i wydajnością pierwiastek a długością życia krów

Trait Cecha	Lifespan of cows depending on culling reason Długość życia krów w zależności od przyczyny brakowania		
	old starość	sale, low milk yield sprzedaż, niska wydajność	other pozostałe
First calving age Wiek pierwszego wycielenia	0.41	0.10	-0.01
Primiparous milk yield Wydajność pierwiastek	0.30	0.32	0.08

15.9%. The same authors also found a negative relationship between survival of primiparous cows and the increase in the age of first calving. Heritability of cow survival to the second lactation is low at around 0.10. This trait is also moderately associated with the other parameters of productive life – total days in milk, length of productive life, and total lifespan [Boichard et al. 1996, Reklewski et al. 2004].

The coefficients of correlation between age at first calving and lifespan varied according to the reasons for culling. They assumed positive values in the groups of cows culled for old age and low milk yield or culled for sale (0.41 and 0.10, respectively), and in the group of cows culled for other reasons, the correlation between these two traits was minimal (-0.01).

The study of Sawa and Krężel-Czopek [2008] showed a marked tendency for the age of cows to increase with a delay in first calving. This fact is confirmed by the positive correlation (0.085) between age at first calving and lifespan.

A slightly different pattern was shown by the correlation coefficients between primiparous milk production and lifespan. They ranged from 0.30 (cows culled for old age, low milk yield, and culled for sale) to 0.08 (cows culled for other reasons). The analysed population was characterized by intermediate first lactation milk yield (around 6500 kg milk). With this level of productivity, the relationship between primiparous milk yield and li-

ifespan is still positive. This is supported by Pytlewski et al. [2010], who demonstrated that the longest lifespan, length of productive life and milking duration were characteristic of the cows with the lowest first lactation milk yield. A reverse tendency is to be expected with increasing production level of the youngest cows. Maximizing the production of this group will result in a significant reduction in the productive period of the cows and decrease their lifetime milk yield [Borkowska and Januś 2009].

High positive correlations were found between age at first calving and lifetime milk yield in the groups of cows culled for old age and those culled for low milk yield and culled for sale – 0.59 and 0.61, respectively (Table 4). This trait was much less related to lifetime production of the cows culled for other reasons (0.09). The entire cow population under analysis showed high positive coefficients of correlation between first lactation milk yield and lifetime milk yield (0.34–0.64).

Analysis of the relationship between age at first calving and cow productivity per day of productive life revealed a positive correlation (0.30) only in the group of cows with the longest productive life (Table 5). In the other groups, these correlations were negative, -0.13 (cows culled for sale and for low milk yield) and -0.26 (cows culled for other reasons). The correlation coefficients for the relationship between primiparous milk yield and daily productivity of the cows during their milk production period and during their lives assumed positive

Table 4. Correlation coefficients of age at first calving and primiparous milk yield with lifetime performance of cows

Tabela 4. Współczynniki korelacji między wiekiem pierwszego wycielenia i wydajnością pierwiastek a wydajnością życiową krów

Trait Cecha	Lifetime performance of cows depending on culling reason Wydajność życiowa krów w zależności od przyczyny brakowania		
	old starość	sale, low milk yield sprzedaż, niska wydajność	other pozostałe
First calving age Wiek pierwszego wycielenia	0.59	0.61	0.09
Primiparous milk yield Wydajność pierwiastek	0.47	0.64	0.34

Table 5. Correlation coefficients of age at first calving and primiparous milk yield with milk production per day of productive life

Tabela 5. Współczynniki korelacji między wiekiem pierwszego wycielenia i wydajnością pierwiastek a produkcją mleka na dzień użytkowania krów

Trait Cecha	Milk production per day of productive life depending on culling reason Produkcja mleka na dzień użytkowania krów w zależności od przyczyny brakowania		
	old starość	sale, low milk yield sprzedaż, niska wydajność	other pozostałe
First calving age Wiek pierwszego wycielenia	0.30	-0.13	-0.26
Primiparous milk yield Wydajność pierwiastek	0.31	0.42	0.47

Table 6. Correlation coefficients of age at first calving and primiparous milk yield with milk production per day of age

Tabela 6. Współczynniki korelacji między wiekiem pierwszego wycielenia i wydajnością pierwiastek a produkcją mleka na dzień życia krów

Trait Cecha	Milk production per day of age depending on culling reason Produkcja mleka na dzień życia krów w zależności od przyczyny brakowania		
	old starość	sale, low milk yield sprzedaż, niska wydajność	other pozostałe
First calving age Wiek pierwszego wycielenia	0.35	-0.34	-0.43
Primiparous milk yield Wydajność pierwiastek	0.29	0.52	0.43

values in all the classes accounting for culling reasons, ranging from 0.39 to 0.47 (Table 5) and from 0.29 to 0.43, respectively (Table 6).

CONCLUSIONS

A fairly early initiation of the productive life and the intermediate productivity level of primiparous cows should result in more favourable parameters of lifetime performance in future. In Poland, data about adaptive capabilities such as age at first calving and primiparous production level, are not considered when improving dairy cows. In addition to these traits, account should also be taken of cow survival to the second lactation, because this trait

encompasses the cow's health issues and the related culling rate and reasons for culling. Inclusion of this trait in the selection criterion would allow choosing those high-yielding cows that will express their production potential many times in their lives.

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ZWIĄZEK MIĘDZY UŻYTKOWOŚCIĄ KRÓW JAKO PIERWIASTEK A ŻYCIOWĄ

STRESZCZENIE

Analizy przeprowadzono na podstawie informacji pochodzących z bazy danych systemu SYMLEK. Uwzględniono dane dotyczące zakończonej użytkowości mlecznej 20 068 krów rasy polskiej holsztyńsko-fryzyjskiej. Dokonano analizy cech produkcyjnych i funkcjonalnych z jednoczesnym uwzględnieniem przyczyn brakowania. Krowy po raz pierwszy cieleły się w wieku 807 dni, a średnia wydajność pierwiastek wynosiła 6 513 kg mleka. W zależności od przyczyn brakowania krów średnia długość ich życia wyniosła od 1 830 dni do 3 156 dni. Najdłużej żyły krowy usuwane ze stad z powodu starości, natomiast najkrócej zwierzęta najmniej wydajne i sprzedawane do dalszego chowu. Krowy użytkowane najdłużej osiągnęły średnią wydajność życiową na poziomie 40 000 kg mleka. Współczynniki korelacji pomiędzy poziomem wydajności pierwiastek a długością życia wyniosły od 0,30 (krowy wybrakowane z powodu starości, niskiej wydajności i sprzedaży) do 0,08 (krowy wybrakowane z pozostałych przyczyn). Analizowana populacja krów charakteryzowała się wysokimi dodatnimi współczynnikami korelacji między wydajnością w pierwszej laktacji a wydajnością życiową (0,34–0,64). We wszystkich klasach krów uwzględniających przyczyny brakowania oszacowano dodatnie korelacje między wydajnością pierwiastek a produkcją mleka przeliczaną na dzień życia i użytkowania krów.

Słowa kluczowe: krowy, brakowanie, długowieczność, wydajność mleczna

