

CORRELATIONS BETWEEN MILK YIELD IN PRIMIPAROUS PHF COWS AND SELECTED LIFETIME PERFORMANCE AND FERTILITY INDICATORS AS WELL AS REASONS FOR CULLING

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Abstract. The aim of this study was to assess the correlation between milk yield in primiparous cows and their subsequent productivity, length of productive life, and reasons for culling. The analysis included 386 Black-and-White Polish Holstein-Friesian cows (PHF-HO) culled from the dairy herd during a 9-year period on one farm. Cows which had high milk yield in their first lactation were also found to be more productive in subsequent lactations. However, high milk yield in the first lactation may be associated with significantly shorter lifespan and productive life, as well as lower lifetime milk yield. The length of intercalving periods was not significantly associated with first lactation productivity. As milk yield increased, a lower proportion of cows culled for sterility and other reproductive disorders was observed, while a higher percentage of cows were eliminated for udder diseases.

Keywords: culling, length of productive life, lifespan, primiparous cows

INTRODUCTION

The effectiveness of milk production in cows depends, among other factors, on their lifespan and on the amount of milk and its components obtained during this period [Brzozowski et al. 2003, Dymnicki et al. 2003, Sawa and Krężel-Czopek 2009]. Length of production life in large dairy cow herds generally does not exceed 3–4 lactations, while on individual private farms it lasts for about 6–7 lactations [Czaplicka et al. 2004, Borkowska and Januś 2006, Varisella et al. 2007, Sawa and Bogucki 2010]. Dorynek et al. [2006] and Różańska-Zawieja and Nienartowicz-Zdrojewska [2008] show that lifespan and length of productive life are closely associated with reasons for culling, which in turn are determined by many factors dependent in varying degrees on the breeder [Sawa and Maciejewski 2000, Smith et al. 2000, Antkowiak et al. 2001, Czaplicka et al. 2004, Sobek et al. 2005, Borkowska and Januś 2006]. While a shorter productive life enables more rapid selection response,

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it does not allow cows to reveal their full production potential and does not guarantee a return of the costs incurred in rearing the heifer [Borkowska and Januś 2004, Sitkowska and Mroczkowski 2005, Różańska-Zawieja and Nienartowicz-Zdrojewska 2008].

The aim of the study was to assess the correlations between milk yield in primiparous cows and their subsequent productivity, length of productive life and reasons for culling.

MATERIAL AND METHODS

The material for the study was collected from a farm in the Lublin region raising Black-and-White Polish Holstein-Friesian dairy cattle. The herd numbered about 230 head of cows whose average milk yield exceeded 8,000 kg. They were kept in free-stall housing and milked in a side-by-side milking parlour (2×15). The summer diet of the cows was based on pasture forage. They also received sugar beet pulp in the form of briquettes. Winter feed rations included silage from meadow grasses and lucerne, hay, and sugar beet pulp. All year they also received wheat bran, pressed maize silage and a mixed mineral supplement.

The analysis included 386 cows culled from the herd over a 9-year period. They had produced 4,762 kg of milk during their first standard lactations, and 5,296 kg in the complete lactations. The following data was obtained from breeding documentation:

- date of birth of each cow and dates of each calving and dry period;
- milk yield in successive lactations (kg milk, kg and % fat and protein);
- dates of cullings and their causes.

Based on the data from the documentation the following were calculated:

- lifespan and length of production life (in days);
- lifetime production of milk, fat and protein (in kg);
- milk yield per day of life and per day of productive life (in kg);
- milk yield in first standard lactation in kg FPCM (Fat and Protein Corrected Milk)

according to the formula [Subnel et al. 1994]:

$$FPCM (kg) = [0.337 + 0.116 \times fat (\%) + 0.06 \times protein (\%)] \times milk (kg);$$

- number of calvings;
- length of intercalving periods (in days);
- length of dry periods (in days);
- number and percentage of cows culled for different reasons.

Statistical analysis was performed using SAS (Pearson's correlation procedure) [SAS® User's Guide 2004]. The effect of the following factors on the traits analysed was taken into account:

- milk yield (kg milk) in primiparous cows in 100 days of lactation (up to 1,500; 1,501–1,900; >1,900);
- milk yield (kg milk) in first standard lactation (up to 4,500; 4,501–5,500; >5,500);
- milk yield in first lactation expressed in kg FPCM (up to 4,500; 4,501–5,500; >5,500).

Significance of the correlation coefficients between the traits analysed was estimated at significance levels of $P \leq 0.01$ and $P \leq 0.05$. Frequency of culling for different reasons depending on milk yield in the first lactation was determined using the χ^2 test.

RESULTS AND DISCUSSION

Correlation coefficients between milk yield in the primiparous cows and indicators of lifetime performance and fertility were negative (Table 1). This dependence was observed between productivity (both in the first 100 days after calving and in the standard lactation) and lifetime production of milk and its components, lifespan, and length of production life. Negative correlations between these traits have been demonstrated by Sitkowska and Mroczkowski [2005]. According to Sawa [2001], predictions of lifetime performance of cows based on milk yield in the first lactation are not always accurate. Haworth et al. [2008] found that none of the cows with average daily yield exceeding 30 kg in their first lactation survived more than two lactations. In a study by Pytlewski et al. [2010 a], the cows with the lowest milk yield in their first lactation had the longest lifespan and productive life. However, positive dependencies between milk yield in primiparous cows and lifespan and length of production life were noted by Sawa and Bogucki [2010].

No significant dependence was found between milk yield in primiparous cows and length of the intercalving period; the coefficients calculated for milk yield in 100 and 305 days and length of ICP were close to zero. An earlier study by Januś and Borkowska [2004] showed that increasing milk yield in the first lactation expressed in kg FCM could be accompanied by prolonged ($P \leq 0.05$) intercalving periods, but the correlation coefficient between these traits was very low ($r = 0.097$). A positive and highly significant ($r = 0.078$) dependence between milk yield and length of ICP was observed by Jankowska [2002].

Increasing milk yield, both in 100 days and 305 days of the first lactation, may be accompanied by a significant increase in milk production per day of life and per day of productive life. This is indicated by the positive and significant ($P \leq 0.01$) correlation coefficients. The coefficients between milk yield in 100 days and per day of life and production life were $r = 0.112$ and $r = 0.668$, respectively. They were higher for milk yield in the standard lactation, $r = 0.138$ and $r = 0.714$ (in kg milk) and $r = 0.194$ and $r = 0.718$ (in kg FPCM). This suggests that standard lactation milk yield in primiparous cows can be a good prognosticator of their lifetime performance. Milk yield in the first third of the first lactation is a less accurate indicator of future performance.

A study by Gnyp et al. [1999] showed that higher milk yield in primiparous cows was associated with fewer calvings during their productive life. A similar dependence was observed in the present study. Correlations between productivity in 100-day and standard lactation and the number of calves born were negative (from $r = -0.371$ to $r = -0.436$) and highly significant. In studies by Sawa and Krężel-Czopek [2009] and Sawa and Bogucki [2010], the dependence between milk yield in primiparous cows and the number of calvings was positive. In a study by Haworth et al. [2008], these traits were not associated.

Milk yield in primiparous cows was also significantly ($P \leq 0.01$ and $P \leq 0.05$) associated with productivity in subsequent standard lactations (Table 2). Correlations between these traits were generally significant ($P \leq 0.01$). They ranged from 0.438 to 0.508 in the case of milk yield, from 0.173 to 0.317 for fat yield and from 0.403 to 0.479 for protein yield. It is worth noting that the correlation coefficients between milk yield during 100 days of the first lactation and production of milk and its components in subsequent lactations were

lower than in the case of standard lactation. This may suggest that in predicting productivity more attention should be paid to standard lactation yield in primiparous cows than to 100-day lactation. When Brzozowski et al. [2003] analysed the effect of the first standard lactation on lifetime productivity, they found that cows that had high yield as primiparas also attained high milk and protein yield in subsequent lactations.

Table 1. Correlation coefficients between milk production during the first 100-day and standard lactation and indices of lifetime performance and fertility
Tabela 1. Współczynniki korelacji pomiędzy wydajnością w pierwszej 100-dniowej i standardowej laktacji a wskaźnikami życiowej użytkowości i płodności krów

Indices of lifetime performance and fertility of cows Wskaźniki życiowej użytkowości i płodności krów	Milk yield – Wydajność mleka		
	in 100 days of 1st lactation, kg za 100 dni I laktacji, kg	during 1st standard lactation w I laktacji standardowej kg	kg FPCM
Lifespan, days Długość życia, dni	-0.412**	-0.433**	-0.391**
Length of production life, days Długość użytkowania mlecznego, dni	-0.422**	-0.441**	-0.401**
Lifetime milk production, kg Życiowa wydajność mleka, kg	-0.235**	-0.237**	-0.189*
Milk production per day of life, kg Wydajność mleka na dzień życia, kg	0.112**	0.138**	0.194**
Milk production per day of productive life, kg Wydajność mleka na dzień użytkowania, kg	0.668**	0.714**	0.718**
Lifetime fat production, kg Życiowa wydajność tłuszczu, kg	-0.302**	-0.309**	-0.233**
Lifetime protein production, kg Życiowa wydajność białka, kg	-0.250**	-0.256**	-0.196**
Average length of intercalving period, days Średnia długość okresu międzywycieleniowego, dni	-0.062	0.005	-0.006
Average length of dry period, days Średnia długość okresu zasuszenia, dni	-0.203**	-0.194**	-0.224**
Number of calvings Liczba wycieleń	-0.371**	-0.436**	-0.393**

** correlation coefficients significant at $P \leq 0.01$ – ** współczynniki korelacji istotne przy $P \leq 0,01$.

* correlation coefficients significant at $P \leq 0.05$ – * współczynniki korelacji istotne przy $P \leq 0,05$.

A marked association was also noted between yield in primiparous cows and duration of lactation. The correlation coefficient between yield in 100 days of lactation and duration of lactation was 0.191 and was significant at $P \leq 0.05$. The coefficients for lactation length and productivity in primiparous cows in 305-day lactation were higher (0.284 and 0.298) and were significant at $P \leq 0.01$.

Table 2. Correlation coefficients between milk production during the first 100-day and standard lactation and productivity of cows in subsequent standard (upper line) and complete (lower line) lactations

Tabela 2. Współczynniki korelacji pomiędzy wydajnością w pierwszej 100-dniowej i standardowej laktacji a produktywnością krów w następnych standardowych (górny wiersz) i pełnych (dolny wiersz) laktacjach

Specification Wyszczególnienie	Length of lactation, days Długość laktacji, dni	Yield of, kg – Wydajność, kg		
		milk mleka	fat tłuszczu	protein białka
Milk yield in 100 days of 1st lactation, kg	0.191*	0.438**	0.173**	0.403**
Wydajność mleka za 100 dni I laktacji, kg	0.116**	0.396**	0.169**	0.362**
Milk yield in 1st standard lactation, kg	0.284**	0.508**	0.236*	0.459**
Wydajność mleka w I laktacji standardowej, kg	0.240**	0.504**	0.269**	0.459**
Milk yield in 1st standard lactation, kg FPCM	0.298**	0.500**	0.317**	0.479**
Wydajność mleka w I laktacji standardowej, kg FPCM	0.248**	0.498**	0.342**	0.478**

** correlation coefficients significant at $P \leq 0.01$ – ** współczynniki korelacji istotne przy $P \leq 0,01$.

* correlation coefficients significant at $P \leq 0.05$ – * współczynniki korelacji istotne przy $P \leq 0,05$.

Sterility and random causes are the reasons most often cited for culling of cows [Sobek et al. 2005, Borkowska and Januś 2006, Pytlewski et al. 2010 b]. The data in Table 3 show that increasing production (in kg milk) in the first standard lactation was accompanied by a decreasing percentage of cows culled for sterility and reproductive diseases. The percentages were 52.4%, 51.2% and 40.7% for the three increasing ranges of yield. When yield was determined in kg FPCM, somewhat different dependencies were observed, as the highest percentage of culling for this reason (52.3%) was noted in the group of cows that produced 4,501–5,500 kg FPCM in the first standard lactation. Sawa and Maciejewski [2000] found that as production level increased, there was a marked increase in the percentage of cows culled for this reason. Jankowska [2002] also noted the lowest (33.48%) percentage of cullings due to sterility in cows with the lowest productivity. In the remaining yield ranges (4,001–5,000 kg, 5,001–6,000 kg, and >6000 kg), the percentages of cullings for this reason were similar and ranged from 41.9 to 45.5%. A study by Januś and Borkowska [2004] showed that 21.4% of cows that produced up to 4,500 kg of milk in their first lactation were culled due to sterility. The proportion of cows culled for this reason was 34.8% in the group with average yield (4,501–6,000 kg) and 47.4% in the most productive group. Sawa et al. [2002] demonstrated that frequency of culling due to sterility increased when primiparous cows exceeded yield of 8,000 kg FCM.

Table 3. Reasons for culling cows depending on productivity (in kg of milk and kg of fat and protein corrected milk) in the first standard lactation

Tabela 3. Przyczyny brakowania krów w zależności od wydajności (w kg mleka i w kg FPCM) w pierwszej standardowej laktacji

Productivity in 1st standard lactation Wydajność w pierwszej standardowej laktacji	Number and % of cows culled for different reasons Liczba i % krów wybrakowanych z różnych przyczyn										Total Ogółem	χ^2		
	udder diseases choroby wymienia		low milk yield niska wydajność		sterility and reproductive diseases jałowość i choroby układu rozrodczego		random causes wypadki losowe		sold for further breeding sprzedaż do dalszego chowu					
	n	%	n	%	n	%	n	%	n	%				
kg of milk kg mleka	≤4,500	37	19.6	15	7.9	99	52.4	34	18.0	4	2.1	189	48.9	30.3*
	4,501–5,500	25	29.8	–	–	43	51.2	11	13.1	5	5.9	84	21.8	
	>5,500	43	38.1	–	–	46	40.7	20	17.7	4	3.5	113	29.3	
kg of fat and protein corrected milk kg FPCM	≤4,500	37	20.5	14	7.8	91	50.6	33	18.3	5	2.8	180	46.6	23.8*
	4,501–5,500	31	27.9	1	0.9	58	52.3	16	14.4	5	4.5	111	28.8	
	>5,500	37	38.9	–	–	39	41.1	16	16.8	3	3.2	95	24.6	
Total – Ogółem		105	27.2	15	3.9	188	48.7	65	16.8	13	3.4	386	100.0	×

* test value significant at $P \leq 0.01$ – * wartość testu istotna przy $P \leq 0,01$.

Diseases of the udder were the second most frequent reason for culling cows (27.2% of the total) in the herd analysed. It was found that the higher the milk yield in the first standard lactation, the higher the percentage of cows culled for this reason. An association between milk yield and culling due to diseases of the udder has also been noted by Sawa and Maciejewski [2000].

In recent years culling of cows due to low yield has become less frequent. This could slow down selection response in the herd [Borkowska and Januś 2006]. Pytlewski et al. [2010 b] report that 5.88% of cows were culled for low yield. In the present study, low yield was the reason for culling of 15 cows (7.9%) which had had the lowest yield (up to 4,500 kg) in their first standard lactation. In the remaining groups, no cullings due to low yield were noted.

In a study by Sawa [2001], increasing FCM yield in primiparous cows was accompanied by an increase in culling due to random causes. No such dependence was confirmed in the present study, as the highest percentage of cows eliminated for this reason was noted in the case of the lowest yield (18.0–18.3%). This was 0.3% and 0.5% higher than in the case of the cows that produced the most milk (>5,500 kg) in their first standard lactation. The high percentage of cullings due to random causes (16.8% in total) could be connected with the free-stall system they were kept in.

In all of the groups, a small percentage of cows were sold for further breeding. The frequency of culling for this reason was not found to be clearly associated with yield in the first standard lactation. The lowest percentages of such cows (2.1 and 2.8%) were noted in the group with the lowest yield.

CONCLUSIONS

The correlation coefficients show that higher yield during the first lactation can be a factor significantly reducing the lifespan and production life of cows and decreasing lifetime production of milk and its components. The length of intercalving periods was not significantly associated with milk yield in the first lactation. Cows with high yield in their first lactation attained high yield of milk, fat and protein in subsequent lactations as well. Culling due to sterility or reproductive diseases was noted least frequently in cows that had produced the highest level of milk in their first standard lactation. The percentage of cows culled from the herd due to diseases of the udder increased with yield in the first lactation. Because the study analysed cows from just one herd, the results must be verified in other herds.

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WSPÓLZALEŻNOŚCI POMIĘDZY WYDAJNOŚCIĄ PIERWIASTEK RASY PHF A WYBRANYMI WSKAŹNIKAMI ŻYCIOWEJ UŻYTKOWOŚCI I PŁODNOŚCI KRÓW ORAZ PRZYCZYNAMI ICH BRAKOWANIA

Streszczenie. Celem pracy była ocena współzależności pomiędzy wydajnością mleka pierwiastek a ich późniejszą produktywnością, długością użytkowania i przyczynami brakowania krów. Analizą objęto 386 krów rasy phf odmiany cb wybrakowanych w ciągu dziewięciu lat z użytkowania mlecznego w jednym gospodarstwie. Wykazano, że krowy o wysokiej wydajności jako pierwiastki charakteryzowały się większą produktywnością także w kolejnych laktacjach. Stwierdzono jednak, że dążenie do wysokiej wydajności w trakcie pierwszej laktacji może istotnie skracać długość życia i użytkowania mlecznego krów oraz zmniejszać życiową wydajność. Długość okresów międzywycieleniowych nie była istotnie związana z poziomem wydajności w pierwszej laktacji. Wraz ze wzrostem wydajności zmniejszał się natomiast odsetek krów brakowanych z powodu jałowości i innych zaburzeń układu rozrodczego, a zwiększał udział usuniętych ze stada z powodu chorób wymienia.

Słowa kluczowe: brakowanie, długość użytkowania, długość życia, pierwiastki

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