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## RELATIONSHIPS BETWEEN MILKING PERFORMANCE OF COWS IN THE FIRST LACTATION AND THEIR LONGEVITY

**Summary.** The aim of the study was to investigate the dependencies between milking performance of cows at first lactation and their lifespan and lifetime yield. Investigations were conducted in a herd of Polish Holstein-Friesian black-and-white cows, located in the Wielkopolska region. Analyses were performed on cows culled in the years 2002-2007 (868 heads). Cows were kept in two loose box barns with straw-littered beds. Feed rations were established using the INRA program. Culled cows were characterised on the basis of the following parameters: lifespan, length of productive life, the number of days of the milking period, age at first calving, lifetime performance, lifetime yield per day of life, per day of productive life and per day of milking period. Lifetime performance of cows was expressed in kilograms of milk, fat corrected milk (FCM), of butterfat and of protein. In this study lifespan, length of productive life, length of milking period and lifetime milking performance of cows and milking performance per day of life, per day of productive life and per day of milking period were analysed depending on the milk yield in the first complete lactation expressed in kilograms of FCM. The longest lifespan, productive life and milking period were found for cows with the lowest milk yield in the first lactation. Cows with varied milking performance in the first lactation did not differ statistically significantly in lifetime productivity expressed in kilograms of milk, butterfat, protein and FCM. Milk yield, yields of butterfat, protein and FCM in cows per day of life, day of productive life and day of milking period increased with an increase in milk production in the first lactation.

**Key words:** cattle, first lactation, yield of milk, longevity

### Introduction

In many countries a considerable role in genetic improvement programs of dairy cattle is played by functional (non-production) traits, which are ascribed the rank of approximately 40-50% in selection indexes. The effect of functional traits on profitability

of breeding increases with the level of productivity in a given population. Some authors observed that at a high, certain level of production it does not pay off to run intensive selection towards unit yield, thus the reduction of production costs gains in importance. Lifespan in cows is a trait of particular value for breeders. From the economic point of view a shortening of productive life leads to an increase in production costs caused e.g. by herd replacement; however, from the breeding point of view it accelerates selection response. In herds with very high yields the mean productive life of cows is approximately 2.5 lactations (OPRZĄDEK and OPRZĄDEK 2006). According to RÓŻAŃSKA-ZAWIEJA and NIENARTOWICZ-ZDROJEWSKA (2008), the average age lifespan of cows in Poland is approximately six years, while the peak of productivity comes between the 3rd and 5th lactation, i.e. cows should live at least seven-eight years. The coefficient of heritability for longevity in Holstein cattle ranged from 0.03 to 0.08 (VANRADEN and KLAASKATE 1993). In a study by HOQUE and HODGES (1980) the genetic correlation between milk yield in the first lactation and lifespan of Holstein cows was 0.56.

An issue of considerable interest not only for breeders of dairy cattle is to investigate a dependency between milk yield of cows in the first lactation and their lifespan and lifetime productivity.

## Material and methods

Investigations were conducted in a herd of Polish Holstein-Friesian black-and-white cows, belonging to the farm of "Hodowla Roślin Szelejewo sp. z o.o.". Analyses were conducted on cows culled in the years 2002-2007 (868 heads).

Annual stocking in the period of analysis ranged from 447 heads (2005) to 487 heads (2002). Cows were kept in two loose box barns with straw littered beds. Manure was removed mechanically every day using a telescope manure loader. Animals used a shelter being an extension of the barn, where they had access to a roofed yard and a feeding trough. Cows were milked twice daily in a herringbone milking parlour (2 × 12) by FARMTEC with a crowd gate and rapid exit facilities.

Feed rations were determined using the INRA program. Cows were fed in the TMR system with the application of six technological groups. Animals throughout the entire experimental period were fed similarly, using feeds produced on the farm. The main bulky feeds included maize silage, lucerne haylage and meadow haylage. Moreover, ensiled maize kernels, pressed ensiled sugar beet pulp and straw were also used. Concentrate was fed depending on the technological group in an amount from 0.7 to 11 kg. Cows were dried six weeks before calving under antibiotic cover. Two weeks before the expected calving date cows were transferred to a calving barn.

Source data on culled cows came from the breeding documentation of the farm, i.e. "heifer cow" charts and official Production Value Appraisal of Dairy Cows documentation (score reports 2).

Culled cows were characterized on the basis of the following parameters: lifespan, length of productive life, number of milking days, age at first calving, lifetime productivity, lifetime productivity per day of life, per day of productive life and per milking day. Lifetime productivity of cows was expressed in kilograms of milk, FCM, butterfat and protein.

Lifespan referred to the period from the date of birth to the date of culling, while the length of productive life was the time from the date of first calving to the date of culling.

The study comprised analyses of lifespan, the length of productive life, milking period and lifetime milking performance of cows and in per day of life, day of productive life and per milking day depending on the milk yield in the first complete lactation expressed in kilograms of FCM. In terms of milk yields in the first lactation the population of experimental cows was divided into the following yield classes: group I  $\leq 7000$  kg, group II 7001-8500 kg, group III 8501-10 000 kg and group IV  $> 10\ 000$  kg.

In the calculations the MS Excel spreadsheet and statistical software package SAS® (SAS® USER GUIDE 2007) were applied. Multivariate analysis of variance was performed taking into consideration the following effects: genotype, year, reason for culling and age at first calving as a concomitant variable. In the calculations of the significance of differences between means the least significant difference (LSD) test was used. Calculations were performed using MEANS and GLM procedures.

## Results and discussion

Table 1 presents results concerning lifespan, the length of productive life, milking period as well as lifetime productivity of cows, depending on milking performance in the first lactation expressed in kilograms of FCM. The statistical analysis showed statistically significant differences between yield groups of cows for lifespan, length of productive life and milking period. The longest lifespan (5.53 years) was found for cows with the lowest milk yield in the first lactation of less 7000 kg FCM, and for animals with productivity within the range of 7001-8500 kg FCM (5.46 years). These two groups of cows differed in terms of lifespan from the other populations of animals. Similar dependencies were recorded for the number of days of productive life. When analyzing the number of milking days it was shown that the lowest value of this trait (886 days) was found for cows with FCM yield of 8501 to 10 000 kg. The mean recorded for this trait in case of this group of animals differed statistically from the analogous means calculated for two groups of cows with the lowest milk yields in the first lactation. In a study by GNYP *et al.* (1999 b) conducted on a population of black-and-white cattle improved towards milking performance using the Holstein-Friesian breed, it was found that a higher milk yield of primiparous cows caused a non-significant shortening of the length of productive life and obtained lifetime milk yield as well as yields of its components. HAWORTH *et al.* (2008), when analyzing the effect of 24 h yield of Holstein cows in the first lactation on their lifespan showed that the biggest longevity was found in these animals, which mean daily yield ranged from 20 to 30 l of milk. In the investigations conducted by the above mentioned authors none of the cows which produced on average more than 30 l of milk survived more than two lactations. In a study by NEUENSCHWANDER *et al.* (2005) it was found that cows selected towards an increase in yield in successive lactations were characterized by more advantageous traits from the point of view of economics of milk production, i.e. health condition and longevity. In a study by HOCKING *et al.* (1988) it was shown that large animals exhibited bigger longevity. Results of investigations conducted by NILFOROOSHAN and

Table 1. Lifetime productivity of cows depending on milk yield in the first lactation expressed in kilograms of FCM

Tabela 1. Produkcyjność życiowa krów w zależności od wydajności mleka w pierwszej laktacji wyrażonej w kilogramach FCM

Trait	≤ 7000 kg FCM N = 195		7001-8500 kg FCM N = 206		8501-10 000 kg FCM N = 220		> 10 000 kg FCM N = 247	
	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
Lifespan (days)	2 020 <sup>ab</sup>	887	1 995 <sup>cd</sup>	667	1 850 <sup>ac</sup>	524	1 852 <sup>bd</sup>	526
Lifespan (years)	5.53 <sup>ab</sup>	2.43	5.46 <sup>cd</sup>	1.83	5.07 <sup>ac</sup>	1.43	5.07 <sup>bd</sup>	1.44
Days of productive life	1 249 <sup>ab</sup>	881	1 226 <sup>cd</sup>	661	1 075 <sup>ac</sup>	512	1 081 <sup>bd</sup>	511
Days of milking period	1 011 <sup>a</sup>	728	996 <sup>b</sup>	567	886 <sup>ab</sup>	434	918	420
Age at first calving (days)	771	52	769	57	775	61	771	73
Milk (kg)	23 232	17 851	25 227	16 144	23 276	11 612	25 469	11 866
Fat (kg)	954	769	1 019	627	950	501	1 029	504
Protein (kg)	775	592	834	484	778	377	851	386
FCM (kg)	23 610	18 606	25 376	15 599	23 559	12 048	25 627	12 184

Means with identical letters in rows differ significantly ( $p \leq 0.05$ ).

EDRISS (2004) indicate a positive effect of age reduction at first calving on lifetime performance of cows, although a lowering of the date of the first calving below 21 months of age has a negative effect on lifetime productivity.

In the investigations conducted by the authors of this study in terms of lifetime productivity of cows expressed in kilograms of milk, butterfat, protein and FCM statistical analysis did not show differences between means. However, a trend was observed for more advantageous values of analyzed milking performance traits to be obtained by a group of cows with the highest yields in the first lactation. GNYP et AL. (1999 a) analysed the effect of the level of milking performance in a herd on milking performance parameters of cows. Those authors showed that animals kept in herds with high levels of milking performance had longer productive lives and longer milking periods and gave higher yields of milk, butterfat and FCM. Moreover, higher performance efficiency indexes were found for these cows than for cows kept in herds with a low level of milking yield.

Table 2 presents results of analyses concerning productivity of cows per day of life, day of productive life and milking period in terms of milk yield in the first lactation expressed in FCM. Statistical analysis showed that milking performance of cows in the first lactation had a highly significant effect on analysed performance traits of cows expressed in terms of day of life, day of productive life and day of milking period.

Table 2. Productivity of cows per day of life, day of productive life and day of milking period depending on milk yield in the first lactation expressed in kilograms of FCM

Tabela 2. Produkcyjność krów w przeliczeniu na dzień życia, dzień użytkowania i dzień użytkowości mlecznej w zależności od wydajności mleka w pierwszej laktacji wyrażonej w kilogramach FCM

Trait	≤ 7000 kg FCM N = 195		7001-8500 kg FCM N = 206		8501-10 000 kg FCM N = 220		> 10 000 kg FCM N = 247	
	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
	Yield per day of life							
Milk (kg)	10.09 <sup>ABC</sup>	4.08	11.66 <sup>AD</sup>	4.20	12.00 <sup>BE</sup>	3.44	13.26 <sup>CDE</sup>	3.12
Fat (kg)	0.41 <sup>ABC</sup>	0.18	0.47 <sup>AD</sup>	0.16	0.49 <sup>BE</sup>	0.15	0.53 <sup>CDE</sup>	0.13
Protein (kg)	0.34 <sup>ABC</sup>	0.13	0.39 <sup>AD</sup>	0.12	0.40 <sup>BE</sup>	0.11	0.44 <sup>CDE</sup>	0.10
FCM (kg)	10.19 <sup>ABC</sup>	4.23	11.69 <sup>AD</sup>	3.91	12.08 <sup>BE</sup>	3.50	13.30 <sup>CDE</sup>	3.13
	Yield per day of productive life							
Milk (kg)	18.14 <sup>ABC</sup>	4.03	20.21 <sup>ADE</sup>	4.60	21.77 <sup>BDF</sup>	4.40	23.97 <sup>CEF</sup>	4.35
Fat (kg)	0.73 <sup>ABC</sup>	0.17	0.81 <sup>ADE</sup>	0.16	0.88 <sup>BDF</sup>	0.17	0.96 <sup>CEF</sup>	0.17
Protein (kg)	0.61 <sup>ABC</sup>	0.13	0.67 <sup>ADE</sup>	0.13	0.73 <sup>BDF</sup>	0.14	0.80 <sup>CEF</sup>	0.14
FCM (kg)	18.23 <sup>ABC</sup>	4.03	20.25 <sup>ADE</sup>	3.93	21.85 <sup>BDF</sup>	4.02	23.99 <sup>CEF</sup>	3.94
	Yield per day of milking period							
Milk (kg)	22.22 <sup>ABC</sup>	3.77	25.16 <sup>ADE</sup>	4.73	26.48 <sup>BDF</sup>	4.27	27.99 <sup>CEF</sup>	4.24
Fat (kg)	0.89 <sup>ABC</sup>	0.17	1.01 <sup>ADE</sup>	0.15	1.07 <sup>BDF</sup>	0.17	1.12 <sup>CEF</sup>	0.18
Protein (kg)	0.74 <sup>ABC</sup>	0.12	0.84 <sup>ADE</sup>	0.12	0.89 <sup>BDF</sup>	0.13	0.94 <sup>CEF</sup>	0.13
FCM (kg)	22.30 <sup>ABC</sup>	3.73	25.20 <sup>ADE</sup>	3.57	26.59 <sup>BDF</sup>	3.85	28.03 <sup>CEF</sup>	3.92

Means with identical letters in rows differ highly significantly ( $p \leq 0.01$ ).

It was shown that the following dependency occurred: yields of milk, butterfat, protein and FCM per day of life, day of productive life and day of milking period increased with an increase in milk production in the first lactation. Cows with the highest yields in the first lactation (> 10 000 kg FCM) differed in terms of all milking performance traits from the other groups of animals at a significance level  $p \leq 0.01$  both in terms of milk productivity per day of life, day of productive life and day of milking period. It was shown – except for the analysis of milking performance traits per day of life – that all populations of cows differed statistically highly significantly from the other groups in all analyzed traits. Only in terms of values per day of life animals with milk yield in the first lactation amounting to 7001-8500 kg FCM and 8501-10 000 kg FCM did not differ in terms of the following traits: yields of milk, butterfat, protein and FCM. HOQUE and HODGES (1980) calculated a genetic correlation between milk yield in the first lactation and milking performance traits per day of productive life and the value of this parameter amounted to 0.93. This indicates that selection towards milk yield in the first lactation is the effect maximizing lifetime milk production per day of productive life.

## Conclusions

1. The longest lifespan, productive life and milking period were found for cows with the lowest milk yield in the first lactation.
2. Cows with varied milking performance in the first lactation did not differ statistically significantly in terms of lifetime performance expressed in kilograms of milk, butterfat, protein and FCM.
3. Yields of milk, butterfat, protein and FCM in cows per day of life, day of productive life and day of milking period increased with an increase in milk production in the first lactation.

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## ZALEŻNOŚCI MIĘDZY UŻYTKOWOŚCIĄ MLECZNĄ KRÓW W PIERWSZEJ LAKTACJI A ICH DŁUGOWIECZNOŚCIĄ

**Streszczenie.** Celem pracy było zbadanie zależności między produktywnością mleczną krów w pierwszej laktacji a długością ich życia i użytkowością życiową. Badania przeprowadzono

w stadzie krów rasy polskiej holsztyńsko-fryzyjskiej odmiany czarno-białej zlokalizowanym w Wielkopolsce. Analizą objęto krowy wybrakowane (868 szt.) w latach 2002-2007. Krowy utrzymywano w dwóch oborach systemem wolnostanowiskowym boksowym z legowiskami ścielonymi słomą. Dawki pokarmowe układano z wykorzystaniem programu INRA. Krowy wybrakowane scharakteryzowano na podstawie następujących parametrów: długość życia, użytkowanie, liczba dni doju, wiek pierwszego wycielenia, wydajność życiową, wydajność życiową w przeliczeniu na dzień życia, użytkowania i doju. Produkcyjność życiową krów wyrażono w kilogramach: mleka, mleka w przeliczeniu na FCM, tłuszczu i białka. W badaniach analizowano długość życia, użytkowania, doju oraz użytkowość mleczną życiową krów i w przeliczeniu na dzień życia, użytkowania i doju w zależności od uzyskanej wydajności mleka w pierwszej laktacji pełnej wyrażonej w kilogramach mleka FCM. Największą długością życia, użytkowania i doju charakteryzowały się krowy o najmniejszej wydajności mleka w pierwszej laktacji. Krowy o zróżnicowanej wydajności mlecznej w pierwszej laktacji nie różniły się między sobą istotnie pod względem statystycznym produkcyjnością życiową wyrażoną w kilogramach: mleka, tłuszczu, białka i mleka FCM. Wydajność mleka, tłuszczu, białka i mleka FCM u krów w przeliczeniu na dzień życia, użytkowania i doju rosła w miarę wzrostu produkcji mleka w pierwszej laktacji.

**Słowa kluczowe:** bydło, pierwsza laktacja, wydajność mleka, długowieczność

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