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EFFECT OF INTER-CALVING INTERVAL DURATION ON COW PRODUCTIVITY IN TWO CONSECUTIVE LACTATIONS

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Abstract. The study was conducted during the years 2005-2007 on a private farm located in Księży Dwór near Działdowo, Province of Warmia and Mazury (NE Poland). The experimental materials comprised 368 Holstein-Friesian cows. The aim of the study was to determine the effect of inter-calving interval (ICI) duration in two consecutive lactations on milk yield and composition. Milk yield in the second lactation reached 7769 kg (305-day lactation) and 8317 kg (full lactation), and was higher than in the first lactation by 1218 kg and 959 kg respectively. Value-corrected milk (VCM) yield was substantially higher, i.e. 8744 kg and 9450 kg. The yield of fat, protein, lactose and dry matter was also higher in the second lactation. Cows with the longest ICI were characterized by the highest yield of milk and milk components. Significant differences between mean values obtained for those cows and cows with shorter ICI were recorded at a level of $p \leq 0.01$ and $p \leq 0.05$. It was found that milk yield in the first lactation and ICI duration may provide a basis for selecting high-performance cows. The high coefficients of simple correlation between ICI duration and milk yield and composition, observed in this study, are indicative of a strong relationship between ICI and cow productivity. The highest values of correlation coefficients (significant at $p \leq 0.01$) were noted with respect to the yield of dry matter ($r = 0.993$), protein ($r = 0.973$), VCM ($r = 0.968$) and fat ($r = 0.942$). The ICI duration x lactation interaction had a significant effect on the yield of milk, VCM, fat, protein, lactose and dry matter ($P \leq 0.01$) as well as on the content of fat and protein ($p \leq 0.05$).

Key words: interactions, inter-calving interval, lactation, milk performance, simple correlations, Value Corrected Milk (VCM)

INTRODUCTION

Modern breeding programs for dairy cattle are directed primarily towards improving the milk performance traits of cows [Juszczak et al. 2003]. Unfortunately, an increase in milk production volume is accompanied by a number of negative phenomena, including metabolic diseases, lameness, abomasal displacement or fatty degeneration of the liver.

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Cows are at the greatest risk of developing diseases from the last day before calving to peak lactation. This is related to negative energy balance: within 12 weeks after calving feed energy intake is lower than energy output in milk, and cows have to mobilize body fat reserves to make up for nutrient deficits [Krzyżewski et al. 2004, Słoniewski and Krzyżewski 2007]. A decline in fertility, which manifests itself in the lack of estrus or the occurrence of silent estrus, is also observed in high-producing cows over this period [Hibner 1987, Pogorzelska et al. 1998]. Insemination efficiency decreases as well, which results in lower values of herd fertility indicators, such as the length of inter-calving interval (ICI) and the number of inseminations per conception, leading to increased culling rates [Amburgh et al. 1997, Anon 2002, Österman 2003, Krzyżewski et al. 2004].

Previous research has shown that milk production is maximized when inter-calving intervals last 365 days [Harrison et al. 1974, Schindler et al. 1991, Quweltjes et al. 1996, Krzyżewski et al. 2004]. However, it seems that the above principle is true only if the annual milk yield per cow does not exceed 7000 kg. In the case of high-producing cows, the period of negative energy balance at the beginning of lactation may be longer, and insemination efficiency may be lower. Therefore, the rest period during the inter-pregnancy interval should be extended, so as not to inseminate cows until they return to positive energy balance [Miciński 2006]. According to some authors [Weller and Folman 1990, Arbel et al. 2001, Strzałkowska et al. 2004], in herds with the average annual milk yield of 9000 kg ICI should last for 390 to 400 days.

Cattle breeders share the opinion that nutritional and environmental factors affect the degree to which genetic potential for milk production is expressed. According to Quweltjes et al. [1996], our knowledge concerning relationships between genetic and nutritional factors, milk production levels and the incidence of particular non-infectious disease is still insufficient. Even a well-balanced, state-of-the-art diet may fail to meet the nutrient requirements of cows.

The aim of the present study was to determine the effect of inter-calving interval (ICI) duration in two consecutive lactations on milk yield and composition in a herd of Holstein-Friesian cows.

MATERIAL AND METHODS

The study was conducted during the years 2005–2007 on a private farm located in Księży Dwór near Działdowo, Province of Warmia and Mazury (NE Poland). The experimental materials comprised 368 German Holstein-Friesian cows purchased from Germany as in-calf heifers. The cows were kept on deep litter, in four free-stall barns, modernized in 2004 (100 cows per barn). The animals had free access to feed since there was a feeding table outside each barn. The mono diet was composed of succulent roughage: grass silage, maize silage, ensilaged maize grain, soybean meal, rapeseed meal, ground rye, mixed pelleted concentrate "Focus" (Cargill Poland) and vitamin premix "Super Premium". Total mixed rations were supplemented with "diamond" yeast metabolites, lime, salt lick and acid sodium carbonate. The cows were fed from a mix-tank.

The cows were divided into five technological groups, based on milk yield and physiological condition. Average daily milk yield in particular groups was as follows: group 1 – above 40 kg, group 2 – 31 to 40 kg, group 3 – 15 to 30 kg, group 4 – below 15 kg. Group 5 comprised dry cows.

Cows were milked twice daily in two herringbone milking parlors (2 x 7, Fullwood Limited Ellesmere Shropshire, England). Milk was stored in a 13 000 liter tank and cooled to 6°C. Technological processes were managed and controlled with the use of Afifarm v.2. 05F software.

All cows were allocated to six groups, depending on inter-calving interval (ICI) duration, which was as follows: group 1 – up to 365 days (standard length), group 2 – between 366 and 405 days, group 3 – between 406 and 445 days, group 4 – between 446 and 485 days, group 5 – between 486 and 525 days, group 6 – more than 525 days. The yield of milk, fat, protein, lactose and dry matter were determined in the first and second lactation (305-day and full). The actual amount of produced milk was converted into the amount of value-corrected milk (VCM), according to the following formula [Arbel et al. 2001]:

$$VCM = -0.05^{x} \text{ milk yield (kg)} + 8.66^{x} \text{ fat (kg)} + 25.98^{x} \text{ protein (kg)}.$$

The results were processed statistically using Statistica 6.1 software [Statsoft® 2003].

The two-factorial analysis of variance was performed, and least squares means (LSM), standard deviations (SD) and simple correlaction coefficients (r) were determined. The significance of differences between means was estimated by Duncan's test

RESULTS AND DISCUSSION

Table 1 presents milk yield and composition in 305-day lactation, depending on the length of ICI and subsequent lactation. Statistically significant ($p \leq 0.05$) differences were noted in all groups with respect to milk yield. The highest VCM yield was recorded in group 6 (8213 kg). The yield of fat (276 kg), protein (248 kg), lactose (390 kg) and dry matter (897 kg) was also the highest in the group of cows with extended ICI (by 160 days in relation to the standard duration of 365 days). Fat and protein content was the highest in group 4, and it differed significantly ($P \leq 0.05$) from the values obtained in the other groups.

In full lactation the highest yield of milk and milk components was attained in the group of cows with the longest ICI, i.e. in group 6 (Table 2). The yield of milk and VCM in this group was 9825 and 11 839 kg respectively. Statistically significant ($p \leq 0.01$) differences were observed between all groups. The yield of fat, protein, lactose and dry matter was also the highest in group 6, and reached 382, 357, 427 and 1231 kg respectively.

Table 1. Milk yield and composition in 305-day lactation, depending on the duration of ICI and subsequent lactation
Tabela 1. Wydajność i skład mleka krów za 305 dni doju w zależności od długości OMW i kolejnej laktacji

Traits Cechy		Experimental groups (ICI duration) Grupy doświadczalne w zależności od długości OMW						Lactations Laktacje		Interaction Interakcje
		< 365	366–405	406–445	446–485	486–525	>525	I	II	
Number Liczebność	head osob.	132	92	55	36	20	33	368	230	368
Milk, kg Mleko, kg	LSM Sd	6886^{a} 1614	7012^{b} 1440	7194^{c} 1671	6858^{d} 1652	7133^{e} 1298	7334^{f} 1579	6551 1282	7769 ^{xx} 1690	xx
VCM, kg	LSM Sd	7718^{a} 1733	7879^{a} 1523	8024^{b} 1716	7694^{c} 1684	7928^{d} 1282	8213^{e} 1748	7312 1297	8744^{xx} 1785	xx
Fat, kg Tłuszcz, kg	LSM Sd	260^{a} 54.9	265^{a} 47.3	270^{b} 49.9	260^{a} 49.1	263^{a} 37.9	276^{b} 53.8	250.1 40.5	288.1^{xx} 56.9	xx
Protein, kg Biłko, kg	LSM Sd	234^{a} 54.1	238^{a} 47.5	243^{b} 54.9	233^{a} 52.6	241^{b} 41.8	248^{c} 53.9	221 40.6	266^{xx} 56.0	xx
Lactose, kg Laktoza, kg	LSM Sd	260 33.4	287 48.5	322 51.2	349 71.8	371 85.0	390 89.6	311 38.1	359 73.0	xx
Dry matter, kg Sucha masa, kg	LSM Sd	849^{a} 191.7	860^{b} 164.7	875^{c} 183.0	842^{d} 189.7	871^{e} 137.4	897^{f} 188.2	806 144.6	948^{xx} 198.2	xx
Fat, % Tłuszcz, %	LSM Sd	3.69^{a} 0.54	3.69^{a} 0.47	3.70^{a} 0.54	3.71^{a} 0.50	3.62^{b} 0.54	3.69^{a} 0.52	3.67 0.49	3.74^{x} 0.55	x
Protein, % Białko, %	LSM Sd	3.41^{a} 0.24	3.41^{a} 0.22	3.39^{a} 0.25	3.42^{a} 0.25	3.36^{b} 0.25	3.39^{a} 0.26	3.37 0.24	3.43^{x} 0.24	x
Lactose, % Laktoza, %	LSM Sd	4.69 0.14	4.70 0.16	4.71 0.11	4.70 0.22	4.72 0.18	4.73 0.17	4.68 0.16	4.74 0.19	x
Dry matter, % Sucha masa, %	LSM Sd	12.39 0.83	12.31 0.70	12.25 0.82	12.35 0.70	12.28 0.75	12.28 0.83	12.38 0.72	12.26 0.86	none brak

Values within a trait with differing superscript letters are significantly different: groups: small letters – ($p \leq 0.05$); lactations: xx – ($p \leq 0.01$), x – ($p \leq 0.05$).

Wartości oznaczone różnymi literami w obrębie cechy różnią się istotnie: grupy: małe litery ($P \leq 0,05$); laktacje: xx – ($P \leq 0,01$), x – ($P \leq 0,05$).

The fat content of milk in full lactation was not too high, and it ranged from 3.63 to 3.74%, while the protein content of milk was high, varying from 3.41% to 3.62%. Statistically significant differences were noted at $p \leq 0.05$. Only the lactose content of milk remained at a comparable level in all groups and in both lactations.

Differences in the yield of milk, VCM, fat, protein, lactose and dry matter (Table 1) as well as in the content of fat and protein (Table 2) during the analyzed lactations, with ICI of varying length, indicate that there exists an interaction between ICI duration and lactation. This interaction is illustrated in Fig. 1, taking the example of milk yield (the effect of this interaction on other traits was similar). The observed changes were affected by ICI lasting longer than 445 days and by a distinct decline in milk production efficiency in the first lactation, compared to the second lactation. The effect of the above interaction on the content of fat, protein and lactose was slightly different: a decrease in the concentrations of milk components in the second lactation, compared to the first lactation, was observed in the group of cows with ICI lasting between 486 and 525 days. Figure 2 shows this interaction taking the example of lactose. No interaction was found between ICI duration and lactation with regard to dry matter content.

Milk yield was higher in the second lactation than in the first lactation, by 15.70% (305-day lactation) and 11.50% (full lactation). Differences between 305-day lactations (Table 1) concerned the yield of milk, VCM, fat, protein and dry matter ($p \leq 0.01$) as well as the content of fat and protein ($p \leq 0.05$). The values of milk performance traits recorded over 305 days of the first lactation show which cows will be characterized by lower productivity and a shorter ICI in the subsequent lactation.

Daumerie et al. [1992] and Reklewska et al. [1999] and demonstrated that the protein-to-fat ratio in milk is highly dependent on nutritional factors. It follows that modification of feeding programs for dairy cattle aimed at intensification (through e.g. increasing the proportion of concentrated feed in the ration) may lead to considerable changes in the chemical composition of milk. On the other hand, a decrease in the proportion of roughages in the ration may reduce the fat content of milk.

Strzałkowska et al. [2004] reported that extended inter-pregnancy intervals (IPI) had no significant effect on actual milk yield during 305-day lactation, which was higher by 297 kg in a group of cows whose IPI was 120 days longer. Differences between experimental groups regarding the yield and content of fat and protein were found to be statistically non-significant. According to Strzałkowska et al. [2004] and Krzyżewski et al. [2004], the optimum length of IPI in cows producing around 9000 kg of milk during lactation is approximately 110 days. These authors made an attempt in their study to inseminate cows during estrus that occurred 42 days postpartum (control group), and then successively extended this period. They demonstrated that in the control group spontaneous IPI lasted 106 days, while in a group of cows with IPI extended by 30 days (in which insemination was initiated on day 110) the average length of IPI was 149 days. The incidence of mastitis was lower, and the incidence of leg diseases was higher in a group of cows with extended IPI.

Table 2. Milk yield and composition in full lactation, depending on the duration of ICI and subsequent lactation
Tabela 2. Wydajność i skład mleka krów w laktacji pełnej w zależności od długości OMW i kolejnej laktacji

Traits Cechy		Experimental groups (ICI duration) Grupy doświadczalne w zależności od długości OMW						Lactations Laktacje		Interaction Interakcje
		< 365	366–405	406–445	446–485	486–525	>525	I	II	
Number Liczebność	head osob.	132	92	55	36	20	33	368	230	368
Milk, kg Mleko, kg	LSM Sd	6886^{a} 1614	7012^{b} 1440	7194^{c} 1671	6858^{d} 1652	7133^{e} 1298	7334^{f} 1579	6551 1282	7769 ^{xx} 1690	xx
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Fat, kg Tłuszcz, kg	LSM Sd	260^{a} 54.9	265^{a} 47.3	270^{b} 49.9	260^{a} 49.1	263^{a} 37.9	276^{b} 53.8	250.1 40.5	288.1^{xx} 56.9	xx
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Lactose, kg Laktoza, kg	LSM Sd	260 33.4	287 48.5	322 51.2	349 71.8	371 85.0	390 89.6	311 38.1	359 73.0	xx
Dry matter, kg Sucha masa, kg	LSM Sd	849^{a} 191.7	860^{b} 164.7	875^{c} 183.0	842^{d} 189.7	871^{e} 137.4	897^{f} 188.2	806 144.6	948^{xx} 198.2	xx
Fat, % Tłuszcz, %	LSM Sd	3.69^{a} 0.54	3.69^{a} 0.47	3.70^{a} 0.54	3.71^{a} 0.50	3.62^{b} 0.54	3.69^{a} 0.52	3.67 0.49	3.74^{x} 0.55	x
Protein, % Białko, %	LSM Sd	3.41^{a} 0.24	3.41^{a} 0.22	3.39^{a} 0.25	3.42^{a} 0.25	3.36^{b} 0.25	3.39^{a} 0.26	3.37 0.24	3.43^{x} 0.24	x
Lactose, % Laktoza, %	LSM Sd	4.69 0.14	4.70 0.16	4.71 0.11	4.70 0.22	4.72 0.18	4.73 0.17	4.68 0.16	4.74 0.19	x
Dry matter, % Sucha masa, %	LSM Sd	12.39 0.83	12.31 0.70	12.25 0.82	12.35 0.70	12.28 0.75	12.28 0.83	12.38 0.72	12.26 0.86	none brak

Values within a trait with differing superscript letters are significantly different: groups: capital letters – ($p \leq 0.01$), small letters – ($p \leq 0.05$); lactations: xx – ($p \leq 0.01$), x – ($p \leq 0.05$).
Wartości oznaczone różnymi literami w obrębie cechy różnią się istotnie: grupy: duże litery – ($p \leq 0{,}01$), małe litery ($P \leq 0{,}05$); laktacje: xx – ($P \leq 0{,}01$), x – ($P \leq 0{,}05$).

The coefficients of simple correlation (Table 3) between ICI duration and milk yield and composition are indicative of a strong relationship between ICI and cow productivity. The values of those coefficients were very high in both the first and second reproductive period. The coefficient of correlation between ICI and VCM yield ranged from r = 0.820 to r = 0.968. The increase in the correlation coefficients was not proportional to ICI extension. The highest values of correlation coefficients were noted with respect to the yield of dry matter (r = 0.915–0.993) and protein (r = 0.903–0.973). As for the content of fat, protein and dry matter in milk the correlation coefficients were negative and lower, irrespective of ICI duration. The values of correlation coefficient were affected to the greatest degree by the fat content of milk, with varied length of ICI. The obtained results testify to the existence of a positive, statistically ($p \leq 0.01$) significant correlation between ICI duration and milk yield, as well as a negative, but less significant, effect of ICI on the content of major milk components. These relationships were observed in both lactations.

Table 3. Coefficients of correlation (r) between ICI duration and some indicators of cow productivity

Tabela 3. Wartości współczynników korelacji (r) pomiędzy długością okresu miedzywycieleniowego (OMW) a wybranymi wskaźnikami produkcyjności krów

ICI, OMW, days – dni		VCM, kg	Fat, kg Tłuszcz, kg	Protein, kg Białko, kg	Dry matter, kg Sucha masa, kg	Fat, % Tłuszcz, %	Protein, % Białko, %	Dry matter, % Sucha masa, %
I lactation I laktacja	I < 365	0.925^{xx}	0.631^{x}	0.957^{xx}	0.972^{xx}	–0.653^{x}	–0.583^{x}	–0.659^{xx}
	II 365–405	0.820^{xx}	0.682^{xx}	0.850^{xx}	0.935^{xx}	–0.450	–0.456	–0.400
	III 406–445	0.907^{xx}	0.439	0.964^{xx}	0.953^{xx}	–0.510	–0.360	–0.509
	IV 446–485	0.896^{xx}	0.689^{xx}	0.916^{xx}	0.969^{xx}	–0.682^{x}	–0.538^{x}	–0.628^{x}
	V 486–525	0.892^{xx}	0.513^{x}	0.944^{xx}	0.956^{xx}	–0.561^{x}	–0.189^{x}	–0.541^{x}
	VI >525	0.953^{xx}	0.720^{xx}	0.973^{xx}	0.973^{xx}	–0.291	–0.308	–0.334
II lactation II laktacja	I < 365	0.946^{xx}	0.866^{xx}	0.963^{xx}	0.981^{xx}	–0.177	–0.038	–0.035
	II 365–405	0.936^{xx}	0.722^{xx}	0.969^{xx}	0.970^{xx}	–0.527^{x}	–0.435	–0.495
	III 406–445	0.853^{xx}	0.452	0.903^{xx}	0.915^{xx}	–0.672^{x}	–0.435	–0.546^{x}
	IV 446–485	0.968^{xx}	0.942^{xx}	0.964^{xx}	0.993^{xx}	–0.651^{x}	–0.301	–0.460
	V 486–525	0.835^{xx}	0.487	0.898^{xx}	0.940^{xx}	–0.695^{x}	–0.385	–0.587^{x}
	VI >525	0.914^{xx}	0.648^{xx}	0.960^{xx}	–0.095	–0.413	–0.461	–0.228

Differences significant at: xx – ($p \leq 0.01$). x – ($p \leq 0.05$).
Istotność różnic na poziomie: xx – ($P \leq 0{,}01$), x – ($P \leq 0{,}05$).

Wielgosz-Groth [2004] also recorded high and statistically significant ($p \leq 0.01$) coefficients of phenotypic correlations between ICI duration and FCM yield. This author demonstrated that selection directed towards increasing milk yield and ICI duration in the first lactation may contribute to improving the lifetime productivity of cows and to extending herd life. Guliński et al. [1996] investigated the impact of selected genetic and

environmental factors on the correlation between ICI duration and the milk performance of cows, and confirmed the existence of a positive, linear regression between ICI duration and FCM yield. ICI extended by one day enabled to increase milk yield by 2.9 kg.

Results of long-term research conducted in the USA [Galton 1997] show that extending ICI from 13.2 to 16.5 months significantly contributed to improving the indicators of the productivity and reproductive potential of cows: culling rates decreased, overall health of cows improved and herd life was extended. Arbel et al. [2001] reported that extended ICI had a beneficial effect on economic indices of milk production, including culling rate which in relatively high in the USA (26.7%) due to infertility.

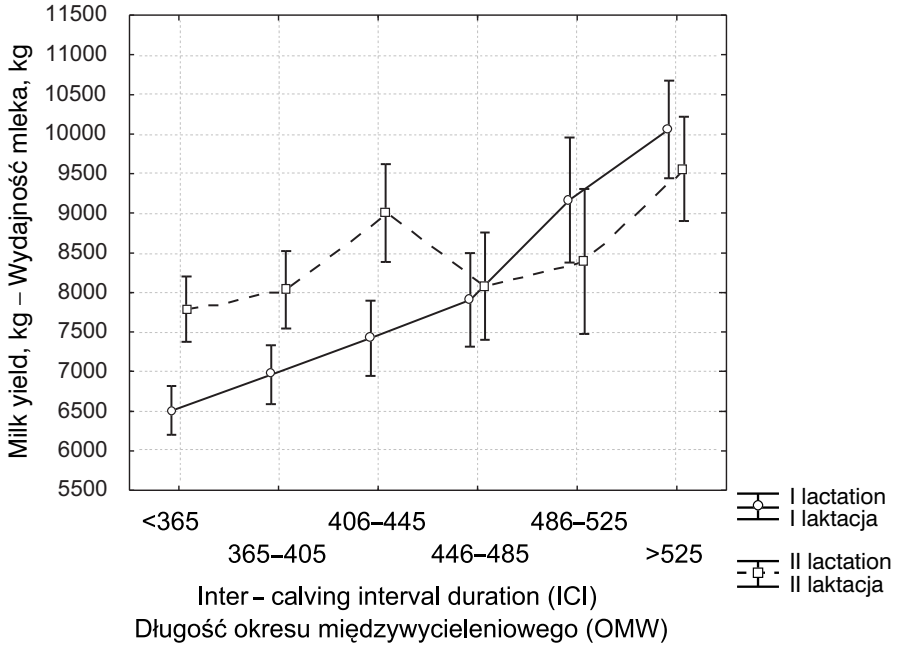

Fig. 1. Effect of the ICI duration x lactation interaction on milk yield in full lactations
Rys. 1. Wpływ interakcji „długość okresu międzywycieleniowego x laktacja" na wydajność krów uzyskaną w laktacjach pełnych

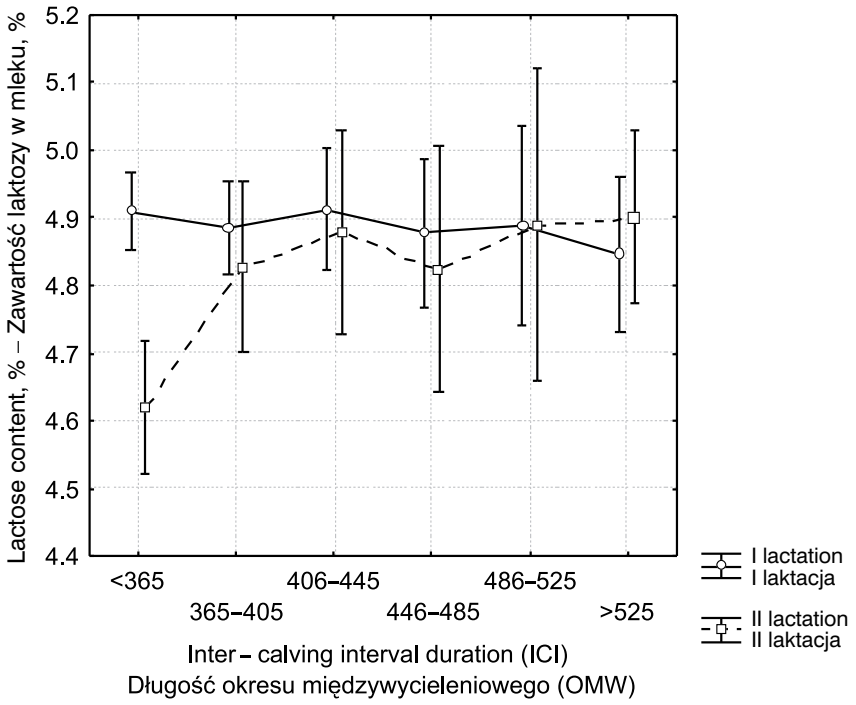

Fig. 2. Effect of the ICI duration x lactation interaction on the lactose content of milk in full lactations

Rys. 2. Wpływ interakcji „długość okresu międzywycieleniowego x laktacja" na zawartość laktozy uzyskanej w laktacjach pełnych

Supporters of the traditional breeding strategies for dairy cattle emphasize the negative consequences of extended ICI, such as a higher incidence of ovarian cysts and vague external symptoms of heat [Grohn et al. 1994]. Weller et al. [1985], Weller and Folman [1990] as well as Larsson and Berglund [2000] share the opinion that extended IPI is associated with certain economic advantages, including a higher milk yield, lower costs of treatment of reproductive system dysfunctions, increased insemination rates and a lower number of semen doses required per conception.

CONCLUSIONS

Value-corrected milk (VCM) yield was 8744 kg and 9450 kg in the first and second lactation respectively. The yield of fat, protein, lactose and dry matter was also higher in the second lactation.

Cows with the longest ICI were characterized by the highest yield of milk and milk components.

The high coefficients of simple correlation between ICI duration and milk yield and composition, observed in this study, are indicative of a strong relationship between ICI and cow productivity. The highest values of correlation coefficients (significant at $p \leq 0.01$) were noted with respect to the yield of dry matter ($r = 0.993$), protein ($r = 0.973$), VCM ($r = 0.968$) and fat ($r = 0.942$).

The "ICI duration ^{x} lactation" interaction had a significant effect on the yield of milk, VCM, fat, protein, lactose and dry matter ($p \leq 0.01$) as well as on the content of fat and protein ($p \leq 0.05$).

It was found that milk yield in the first lactation and ICI duration may provide a basis for selecting high-performance cows.

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WPŁYW DŁUGOŚCI OKRESU MIĘDZYWICIELENIOWEGO NA PRODUKCYJNOŚĆ KRÓW W DWÓCH KOLEJNYCH LAKTACJACH

Streszczenie: Badania realizowano w prywatnym gospodarstwie rolnym w Księżym Dworze k. Działdowa w latach 2005–2007. Materiał stanowiło 368 krów rasy holsztyńsko-fryzyjskiej. Celem pracy było wykazanie wpływu długości okresu międzywycieleniowego w kolejnych dwóch laktacjach na wydajność i skład mleka. W badaniach wykazano, że wydajność mleka krów w II laktacji wynosiła 7769 (za 305 dni doju) i 8317 kg (za pełną) i była wyższa w stosunku do I laktacji odpowiednio o: 1218 i 959 kg. Przy przeliczeniu na zawartość VCM wydajność ta był dużo wyższa i wynosiła odpowiednio: 8744 kg i 9450 kg. Wydajność tłuszczu, białka, laktozy i suchej masy była także wyższa w laktacji II. Najwyższą wydajnością mleka oraz badanych składników cechowały się krowy o najdłuższym okresie międzywycieleniowym (OMW). Różnice pomiędzy średnimi cech uzyskanymi od krów o krótszych okresach odnotowano na poziomie $p \leq 0,01$ i $p \leq 0,05$. Stwierdzono, że na podstawie wydajności w I laktacji i długości OMW można wybrać krowy, które w dalszym użytkowaniu cechują się wyższą produkcyjnością i wykorzystać te informacje przy selekcji zwierząt. Odnotowano wysokie wartości współczynników korelacji prostej pomiędzy OMW a wydajnością i składem mleka, wskazujące na silny związek OMW z produkcyjnością krów. Największe wartości istotne na poziomie $p \leq 0,01$ dotyczyły wydajności: suchej masy ($r = 0,993$), białka ($r = 0,973$), mleka VCM ($r = 0,968$) i tłuszczu ($r = 0,942$). Wykazano wpływ interakcji „długości OMW x laktacja" na poziomie $p \leq 0,01$ dla wydajności mleka, mleka VCM, tłuszczu, białka, laktozy i suchej masy oraz na poziomie $p \leq 0,05$ na zawartość tłuszczu i białka.

Słowa kluczowe: interakcje, korelacje proste, laktacja, mleko VCM, okres międzywycieleniowy, wydajność krów

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