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Short communication

Trend in fertility outcomes of dairy cows in north-eastern Poland over the past 20 years

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Abstract

The aim of the study was to evaluate changes in fertility outcomes in several dairy cow herds over the past 20 years in north-eastern Poland. In calving season 2003-2004, 1215 Polish Black and White x Holstein Friesian from 8 herds were used. The average milk yield was about 5000 kg/cow/year. In calving season 2023-2024, 942 Polish-Black-and-White Holstein Friesian cows from 5 herds were used. The average milk yield was 9200 kg/cow/year. First-service conception rate, number of services per conception, length of inter-calving period and culling rate due to infertility were calculated. The average first-service conception rate decreased from 54.5% to 47.0% and the average number of services per conception increased from 1.8 to 2.2. In 2003-2004, the average length of the inter-calving period was 395.3 ± 53.7 days, while in 2023-2024 it was 407.5 ± 55.5 days. The average culling rate due to infertility increased from 4.6% to 11.7%. Differences in all these fertility parameters between calving seasons were statistically significant ($p \leq 0.05$). The study showed that the fertility outcomes of dairy cows in north-eastern Poland decreased significantly as milk yield increased between 2003-2004 and 2023-2024.

Keywords: dairy cows, fertility, milk yield

Introduction

The fertility of dairy cows has declined worldwide over the past five decades of the twentieth century (Lucy 2001). The reduced fertility is mainly due to an increase in postpartum clinical problems, poor oestrus expression, defective oocytes/embryos and uterine infections (Dobson et al. 2007, Walsh et al. 2011). The primary components of this decline have been a lower conception rate, increased the number of services per conception and inter-calving interval (Mee 2004). In Belgium, the inter-calving interval increased from 390 days in 1996 to 417 days in 2008. The number of services per conception rose from 1.4 to 1.8 in the same period (De Kruif et al. 2008). The decline in fertility can be explained by management changes and negative correlation between milk production and fertility (Walsh et al. 2011). For many countries, an improvement in phenotypic and genetic trends for female fertility has been observed from the early to

Table 1. Fertility parameters in eight dairy herds 2003-2004.

Variables	Herds								Total
	A n=132	B n=362	C n=114	D n=167	E n=122	F n=80	G n=157	H n=81	1215
First-service conception rate (%)	59.1[e]	63.0[c]	38.6[bdf]	48.5[bd]	54.9	31.2[bdf]	40.1[bd]	62.9[a]	54.5
Inter-calving interval (days, mean ± SD)	406.2± 53.5[a]	380.5±57.1[bd]	374.3±47.[1b]d	397.8±60.3[b]	386.4±58.2[b]	400.6±62.4[a]	392.0±56.7[bc]	381.5±59.2[b]	395.3±53.7
Services per conception	1.5	1.6	1.7	1.9	1.8	2.1	2.0	1.8	1.8
Culling rate due to infertility (%)	9.8[a]	2.5[b]	4.4	5.3	2.4[b]	7.5	5.7	2.5[b]	4.6

Values with different letters differ significantly at p≤0.05.

Table 2. Fertility parameters in five dairy herds 2023-2024.

Variables	Herds					Total
	A n=190	B n=260	C n=300	D n=115	E n=77	942
First-service conception rate (%)	48.4	45.0	47.3	48.7	46.7	47.0
Inter-calving interval (days, mean ± SD)	404.4±50.9[b]	401.3±47.0[b]	417.7±57.9[a]	402.6±57.4[a]	407.5±55.5	407.5±55.5
Services per conception	2.1	2.2	2.3	2.2	2.0	2.2
Culling rate due to infertility (%)	13.7	12.6	14.0	10.4	7.9	11.7

Values with different letters within a row differ significantly at p≤0.05.

mid-2000s, largely as a consequence of introducing breeding values for fertility and better reproductive and nutritional management (Crowe 2018).

In 2003, there were 2.9 million cows with an average milk yield of 3900 kg/cow/year, while in 2023, there were 2.3 million cows with an average milk yield of 6800 kg/cow/year in Poland (GUS 2004, 2024).

However, there are only few data about development of fertility in dairy cows in Poland with an increased milk yield over the long term (Neja et al. 2013). The aim of the study was to evaluate changes in fertility outcomes in several dairy cow herds over the past 20 years in north-eastern Poland.

Materials and Methods

The herds were included in the Herd Health Program (Barański et al. 2005). The study was approved by the Ethics Committee for Animal Experiments (Approval No. 49/2016). Cows were housed in free stall barns and fed a total mixed ration based on grass silage, corn silage, concentrate and vitamin and mineral supplements.

In calving season 2003-2004, 1215 Polish Black and White x Holstein Friesian from 8 herds were used. During the summer, the cows were fed green fodder, grass silage and concentrate, during the winter grass silage, corn silage, concentrate and vitamin and mineral supplements. The average milk yield was about 5000 kg/cow/year. In calving season 2023-2024, 942 Polish-Black-and-White Holstein Friesian cows calving from 5 herds were used. The cows were fed a total mixed ration based on grass silage, corn silage, concentrate and vitamin and mineral supplements. The average milk yield was 9200 kg/cow/year. The cows were inseminated artificially during detected estrus. The following fertility parameters were calculated from recorded data: first-service conception rate, services per conception, length of inter-calving period and culling rate due to infertility.

Statistical analysis was performed using GraphPad Prism version 10.00 (GraphPad Software, San Diego, CA, USA). The differences in the length of the inter-calving interval and in the number of services per conception were analysed with a one-tailed non-parametric Mann-Whitney U test. The differences in the first AI conception rate and culling rate due to infertility were analysed using Fisher's exact test.

Results and Discussion

Cows' fertility parameters in the individual herds in 2003-2004 are presented in Table 1.

The first-service conception rate varied from 31.2% to 62.9%. The inter-calving interval varied from 374.3 ± 47.1 to 406.2 ± 53.5 days. Cows' fertility parameters in the individual herds in 2023-2024 are presented in Table 2. The number of services per con-

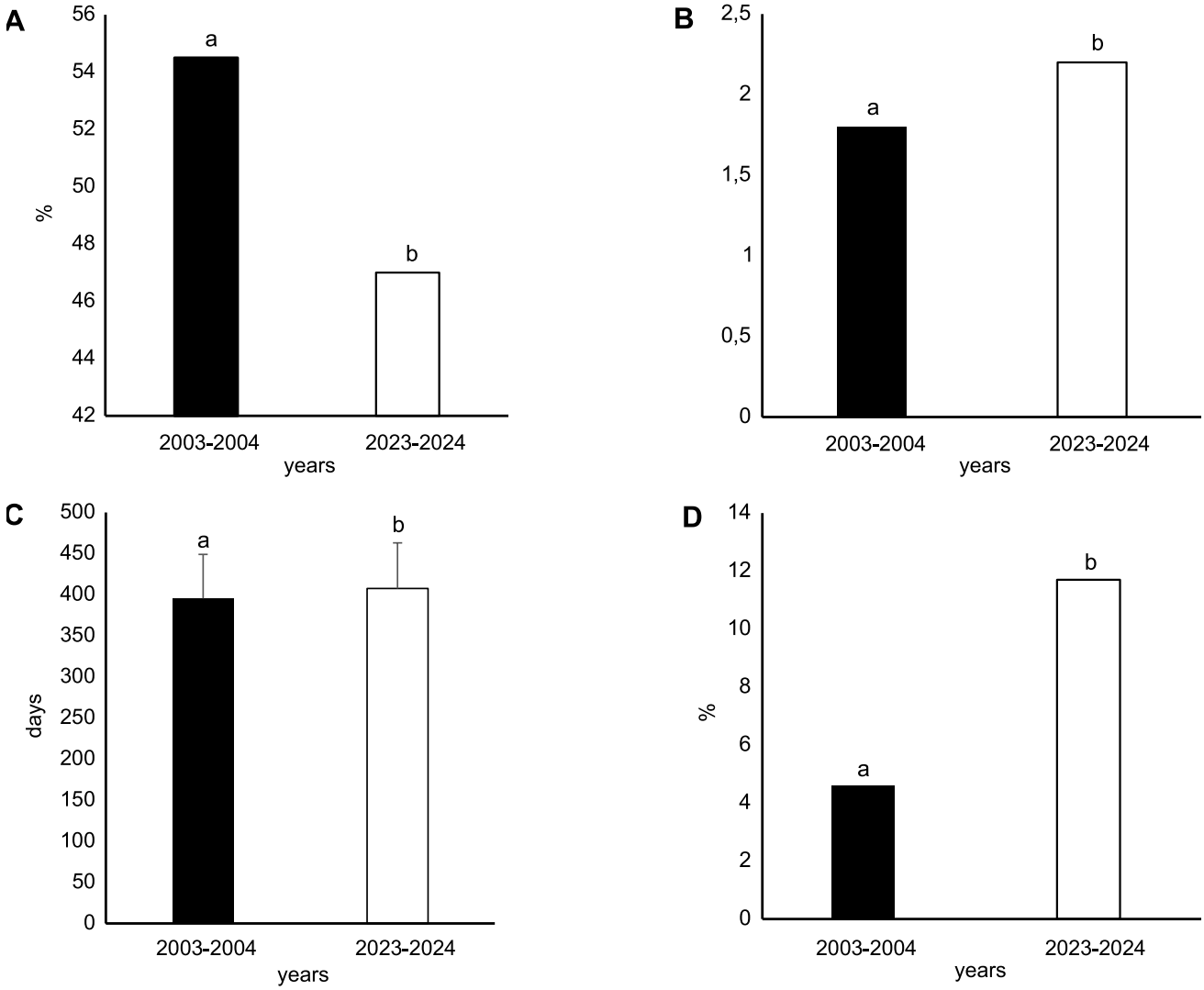

Fig. 1. Fertility outcomes of dairy cows calving 2003-2004 and 2023-2024. (**A**) The average first-service conception rate. (**B**) The average and number of services per conception. (**C**) The average length of the inter-calving interval. (**D**) The average culling rate due to infertility. Different superscript letters indicate statistical significance at $p<0.05$.

ception varied from 2.0 to 2.3. The culling rate varied from 7.9% to 14%. Comparison of the average value of the fertility parameters for 2003-2004 and 2023-2024 is presented in Figure 1.

Our study showed that the fertility of dairy cows in north-eastern Poland significantly declined over the past 20 years. This declining trend in fertility of dairy cows is similar to that observed in other countries (Butler et al. 1998, De Kruif 2008). It is considered that the fertility of the modern dairy cow is getting lower with increasing milk yields (Lucy 2001, Dobson et al. 2007). The significant correlation between milk yield and fertility of dairy cows was also observed in Poland (Krzyżewski et al 2004, Januś i Borkowska 2006, Bogucki et al. 2007, Borkowska et al. 2012). The average length of inter-calving period was 395.3 days, and did not significantly exceed the recommended length of 380-395 days (PFHBiPM, 2024). There were great variations between herds in first service conception rate and the length of inter-calving period. This was probably due to differences in feeding and housing conditions and in the effectiveness of heat detection. Compared to 2003-2004, cows' fertility indices 2023-2024 worsened significantly. This was presumably the result of similar nutritional and reproductive management in the herds. The significant decrease in the first-service conception rate over the past twenty years is in line with data from other countries (Butler et al. 1998, De Kruif 2008). Siatka et al. (2018) reported the average first-conception rate of 44.0% for primiparous Polish Friesian-Holstein cows and its decline by around 4% with the increasing herd production level from < 7000 kg/cow/year to 7000-9000 kg/cow/year. The length of the inter-calving interval has a deciding influence on the length of lactation (Sawa and Bogucki 2010). Neja et al. (2013) analysed data from milk recording and

found that milk yield of Polish-Black-and-White Holstein Friesian increased from 5877 kg/cow/year in 2003 to 7041 kg/cow/year in 2009, and inter-calving period increased at the same time from 414 days to 428 days. According to data from the Polish Federation of Cattle Breeders and Dairy Farmers the average milk yield of cows under milk recording was 9150 kg/cow/year in 2023, and the average length of inter-calving period was 420 days (PFHBiPM 2024).

Several studies showed that genetic correlations between milk production and fertility traits are antagonistic, indicating that selection for increased milk production results in genetically less fertile cows (Tiezzi et al. 2012, Jayawardana et al. 2023). However, declined fertility in high-yielding cows is a multifactorial problem, and the effects of increased milk production on reproduction are relatively minor compared with the effects of other factors, such as poor nutrition, housing, management and skills of herd workers (LeBlanc 2013). High-yielding cows have a high energy requirement at the start of lactation, only partly covered by the feed consumption. The remaining demand is covered by mobilising body reserves (Grummer 2007). A negative energy balance increases the risk of metabolic diseases, causes a drop in body condition score and reduces immunity. This predisposes to ovarian disorders, mastitis, inflammatory diseases of the uterus and lameness, which contribute to a decrease in fertility (Roche 2006). Moreover, elevated metabolic activity in lactating dairy cows increases steroid metabolism and reduces circulating estrogen and progesterone concentrations (Wiltbank et al. 2006). These changes in reproductive physiology lead to reduced oestrus expression and fertilisation failure or embryo mortality due to poor oocyte and embryo quality and consequently to decrease in first-service conception rate and increase in the length of inter-calving period. However, with proper nutrition and management, high level of milk production can be compatible with good reproductive performance in dairy cows (LeBlanc 2013). In conclusion, the study showed that the fertility of dairy cows in north-eastern Poland decreased significantly as milk production per cow increased between 2003-2004 and 2023-2024.

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