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Culling reasons as related to lifetime dairy performance in Polish Friesian (Black-and-White) cows on Pawłowice farm in the years 1909-2006

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Relationships were estimated between longevity, culling reasons and yield of milk and milk components in the I, II and III 305-day lactations and lifetime dairy performance. ANOVA with Duncan test was applied. Cows culled for health problems showed the highest lifetime dairy performance; those kept in the herd for a short of time were culled because of hard milking and behavioural problems or were sold for breeding.

KEY WORDS: cows / cattle / culling /dairy performance / lifetime mik production /milk

Culling is the departure of cows from the herd because of sale, slaughter, salvage or death [Fetrow *et al.* 2006]. Until now, breeding programs in Poland mainly aimed at the improvement of milk production of Polish Friesian (Black-and-White) cows with different per cent of Holstein-Friesian genes, leading to a rapid progress over the last 40 years [Reklewski *et al*. 2004]. Increase in milk production is not always directly related to economic efficiency of the herd. In highly productive herds, health and metabolic disorders are often recorded leading to reduced longevity, high cost of veterinary service and higher investments on reproduction. Smith *et al*. [2000]

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reported that in highly productive herds, more cows were culled for reproduction problems, *mastitis* and feet-and-legs diseases than in herds of low production indicators. Recently, numerous authors have demonstrated that with the production increase, the culling reasons changed [Pawlina *et al.* 1997, Smith *et al.* 2000, Piech and Tarkowski 2002, Booth *et al.* 2004, Reklewski *et al.* 2004].

Tracking down data spanning over nearly 100 years allowed the authors of the present report to expand earlier investigations that were virtually limited to 1-2 generations. Such a long time-span made it possible not only to investigate the longevity of the examined cows but also to study its alterations associated with changes realized within the framework of breeding programme.

The objective of this study was to identify relationships existing between longevity, reasons of culling and milk, fat and protein yield in 305-day lactations and lifetime production of milk and milk components.

Material and methods

Records of milk, milk fat and milk protein yields were analysed for the first three lactations and lifetime production of a total of 6454 dairy cows kept in the years 1909-2006 on the Experimental Farm Pawłowice of the National Research Institute of Animal Production. The data were corrected for days-in-milk using linear regression [Szyszkowski *et al*. 1991]. Based on the available records 19 classes of culling reasons were distinguished. The description of culling subclasses and their frequency over the analysed period of 98 years were given by Varisella *et al.* [2007]. The effect of culling class on milk, fat and protein yield for three lactations and lifetime production were estimated using ANOVA with Duncan test. The SAS system [SAS/STAT 2004] was used for the computations.

Model l:

$$Y_{ijkl} = \mu + R_i + YS_j + P_k + e_{ijkl}$$

Y_{ijkl} – data vector (lifetime yield or I, II and III lactation yield)

Model 2:

$$Y_{ijklm} = \mu + R_i + YS_j + P_k + D_l + e_{ijklm}$$

Model 3:

$$Y_{ijklm} = \mu + R_i + YS_j + P_k + L_l + e_{ijklm}$$

where:

Y_{ijkl} – data vector (lifespan in days/number of months of lactation);

μ – general mean;

R_i – fixed effect of the i-th HF (Holstein Friesian) genotype;

YS_j – fixed effect of the j-th year and calving season;

P_k – fixed effect of the k-th culling reason;

D_l – fixed effect of the l-th milk/fat/protein yield in a lifetime yield;
L_l – fixed effect of the l-th milk/fat/protein yield in a lifetime yield;
e_{ijklm} – effect of random error.

Results and discussion

In Table 1 given are means for lifetime yields of milk, fat and protein as well as longevity and months-in-milk within the culling subclasses. Cows with the highest longevity culled because of age showed the highest milk and milk fat lifespan yield. This group of animals differed highly significantly from the other culling classes. There were no significant differences in lifetime milk and fat yield among groups of cows which left the herd for diseases, perinatal problems, deaths, random events, reproduction problems and poor body condition. All the above-given reasons (except for random events) were directly related to the animals' health. Cows sold for breeding were characterized by the lowest lifetime production. In the herd being subject of this study these animals were kept only until lactation II. No significant differences were identified between culling reasons due to type traits and pedigree, milking problems, sale for breeding, low production, behaviour and unexpected slaughter. Production of these cows was significantly lower than of those that left the herd because of health problems. The highest protein yield (significantly different from other groups) was recorded in the group of cows culled because of age, whereas hard milking cows (*i.e.* those with milk flow disorders even after massage, or with low milking efficiency) had the lowest lifetime protein yield. Cows culled because of type traits and pedigree, as well as milking and behavioural problems showed the shortest herd lifetime.

Table 2 presents means for milk fat and milk protein yield in the first three lactations. The high yield in lactation I had a significant effect on culling due to health problems. Cows with the highest milk, fat and protein yield left the herd most frequently because of deaths and circulatory diseases. In lactation III, the most important reason for leaving the herd by high-fat producing cows were circulatory diseases, whereas for milk and protein producers – simply deaths. Cows that left the herd because of infectious diseases showed significantly lower milk yield The most often slaughtered animals were those with the lowest yield in lactation I. Cows with lower milk and protein yields in lactation III were culled because of behavioural problems. Culling because of udder diseases was related to the decreased milk yield in lactation I, which, however, was later improved reaching 6000 kg milk. Milk, fat and protein yields tended to increase in the consecutive lactations, with the yield in lactation I significantly lower than in the other two.

Piech and Tarkowski [2002] analysed average dairy cow lifetime performance considering four culling reasons. For cows culled because of infectious diseases and random events, the average milk yield was higher in the herd analysed in this study,

Table 1. Lifetime milk, milk fat and milk protein yields, months-in-milk and longevity of cows eliminated from the Pawłowice herd for various reasons in the years 1909-2006

Elimination reason	Lifetime milk yield (kg)	Lifetime fat yield(kg)	Lifetime protein yield(kg)	Months-in-milk	Longevity (months)
Type traits and pedigree	13035^{FGHI}	541.2^{EFG}	371.3^{BCd}	24.9^{De}	59.0^{Df}
Circulatory system diseases	22453^{BCD}	939.8^{BC}	613.9^{BC}	34.8^{BCD}	70.8^{BCDef}
Udder diseases	23623^{BC}	954.4^{BC}	675.2^{AB}	39.6^{BC}	76.9^{BCd}
Metabolic and digestive disorders	19750^{BCDEF}	809.7^{BCDE}	619B^{Cb}	32.3^{BCDe}	68.6^{BCDef}
Foot and leg problems	25616^{B}	1045.4^{B}	700.3^{AB}	44.3^{B}	82.4^{B}
Infectious diseases	18546^{BCDEFG}	737.4^{BCDEF}	413.4^{CBd}	38.5^{BC}	74.5^{BCDe}
Hard milking	10834^{HIg}	441.0^{GF}	131.0^{Cd}	24.3^{De}	60.1^{Df}
Sale for breeding	10020^{Ih}	382.7^{Gf}	284.7^{CBd}	24.0^{De}	61.6^{CDef}
Tumours	17868^{CDEFGH}	718.7^{CDEF}	452.4^{CBd}	35.1^{BCD}	70.6^{BCDef}
Others	15844^{DEFGHI}	607.4^{DEFG}	464.3^{BCd}	32.6^{BCDe}	67.5^{BCDef}
Low production	14501^{EFGHI}	594.5^{DEFG}	379.7^{CBd}	30.6^{CDe}	66C^{BDef}
Death	21714^{BCDE}	884.8^{BCD}	697.1^{AB}	31.9^{BCDe}	67.5^{BCDef}
Reproduction	21234^{BCDE}	875.1^{BCD}	650.2^{BC}	37C^{BDc}	73.2^{BCDe}
Slaughter	11422^{Fgh}	378.3^{Gf}	232.8^{BCd}	33.3^{BCDe}	81.1^{Bc}
Poor condition	21183^{BCDE}	883.0^{BCD}	665.6^{ABCb}	34.5^{BCD}	70.5^{BCDef}
Age	50470^{A}	2059.8^{A}	1165.5^{A}	96.6^{A}	147.9^{A}
Behaviour	10744^{HIg}	432.4^{FGf}	335.4^{BCd}	24.2^{De}	58.5^{Df}
Retained placenta and parturient paresis	22888^{BCD}	947.1^{BC}	710.2^{AB}	35.2^{BCD}	71.2^{BCDef}
Random events	19292^{BCDEF}	779.8^{BCDE}	590.0^{BC}	32.9^{BCDe}	68.9^{BCDef}
Mean	13670.67	777.7793	581.241	35.6	72.4

$^{aA...}$Means within columns bearing different superscripts differ significantly at: small letters – P≤0.05; capitals – P≤0.01.

Table 2. Milk, milk fat and milk protein yields in the first three 305-day lactations across elimination reasons from the Pawłowice herd in the years 1909-2006

Elimination reason	Milk yield (kg)			Fat yield (kg)			Protein yield (kg)		
	lactation I	lactation II	lactation III	lactation I	lactation II	lactation III	lactation I	lactation II	lactation III
Type traits and pedigree	5339.5^{CDEF}	6445.1^{BCDef}	6610^{ABCDEf}	214.49^{CDEFGH}	271.30^{ABCDef}	280.78^{ABCD}	179.83^{ABCde}	221.28^{ABCDe}	220.91^{ABCed}
Circulatory system diseases	6515.9^{AB}	7830.6^{ABC}	7384.2^{ABC}	269.69^{AB}	336.17^{A}	325.96^{A}	226.52^{AB}	285.06^{A}	267.62^{ABc}
Udder diseases	6031.6^{ABCD}	6934.3^{Abcd}	6981.2^{ABCDe}	248.54^{ABC}	291.20^{ABCd}	288.43^{ABC}	204.99^{ABCd}	241.19^{ABCD}	242.86^{ABCd}
Metabolic and digestive disorders	6166.1^{ABC}	7144.1^{ABC}	7100^{ABCDe}	251.78^{ABC}	298.97^{ABc}	298.94^{ABC}	216.61^{ABC}	263.60^{ABC}	257.98^{ABcd}
Foot and leg problems	5654.5^{BCDE}	6515.5^{ABcdef}	6788.2^{ABCDEf}	230.39^{CDEF}	273.12^{ABCDef}	282.08^{ABCD}	194.09^{ABCde}	226.17^{ABCDe}	237.8B^{ACbd}
Infectious diseases	4702.3^{FGe}	5490.8^{Afgh}	5724.6^{DEFGh}	188.63^{Hfg}	224.79^{DEfgh}	232.70^{CDE}	165.59^{Cde}	192.44^{CDe}	201.54^{BCed}
Hard milking	4527.4^{FG}	5832.1^{ABCefgh}	6001.4^{CDEFgh}	192.5^{FGH}	247.97^{BCDEfg}	251.25^{ABCDE}	167.33^{Cde}	191.94^{CDe}	
Sale for breeding	4590.5^{FG}	4946^{ABChi}	5292.4^{EFGhi}	179.24^{Hg}	194.50^{Efh}	208.08^{Efd}	200.84^{ABCde}	233.89^{ABCDe}	242.41^{ABCd}
Tumours	5187.9^{DEF}	6025.9^{ABCDefg}	6063.4^{BCDEFgh}	208.19^{DEFGH}	245.54^{BCDEf}	254.83^{ABCDE}	183.14^{ABCde}	206.21^{BCDe}	216.59^{ABCde}
Others	4867.9^{EFG}	5855.4^{ABCDefgh}	6470.2^{ABCDEF}	190.1^{GHf}	227.96^{CDEfgh}	256.88^{ABCDE}	190.9^{ABCde}	245.68^{ABCD}	281.82^{A}
Low production	4869.6^{EFG}	5750.9^{ABefgh}	5971.2^{CDEFgh}	199.38^{EFGHg}	242.37^{BCDEfgh}	247.86^{BCDE}	168.54^{BCde}	204.03^{BCDe}	209.71^{ABCde}
Death	6806.5^{A}	7767.6^{ABCD}	7779^{A}	279.42^{A}	325.91^{Ab}	322.06^{AB}	233.3^{A}	275.96^{AB}	276.41^{AB}
Reproduction	5751.2^{BCD}	6761B^{Abcde}	6856^{ABCDef}	236.94^{BCDE}	283.91^{ABCde}	287.50^{ABC}	196.77^{ABCde}	236.77^{ABCD}	240.27^{ABCd}
Slaughter	4078.8^{G}	4084.8^{ABCDi}	4391.5^{Gi}	142.57^{Ih}	142.78^{Fi}	150.21^{Fe}	158.86^{Ce}	-	-
Poor condition	5793.2^{BCD}	6989.1^{ABCd}	7115.6^{ABCDe}	240.67^{ABCD}	301.55^{ABc}	303.81^{ABC}	201.45^{ABCde}	245.21^{ABCD}	242.84^{ABCd}
Age	4795^{FGe}	5789.5^{ABefgh}	6312.4^{ABCDEFg}	192.4^{FGH}	237.49^{BCDEfgh}	259.34^{ABCDE}	166.46^{Cde}	212.38^{ABCDe}	226.68^{ABCde}
Behaviour	4569^{FG}	5023.8^{ABCDghi}	5072.4^{FGhi}	181.46^{Hg}	200.53^{Efgh}	211.77^{DEF}	165.63^{Cde}	179.78^{De}	175.30^{Ce}
Retained placenta and parturient paresis	6505.6^{AB}	7451.2^{ABC}	7617.3^{AB}	270.93^{AB}	315.46^{Abc}	320.90^{AB}	217.61^{ABC}	261.53^{ABC}	263.17^{ABc}
Random events	5664.4^{BCDE}	6805.1^{BCDea}	7204.7^{ABCD}	229.00^{CDEFG}	278.63^{ABCDe}	292.33^{ABC}	207.03^{ABCd}	247.43^{ABCD}	260.1B^{Acbd}
Mean	5416.939	6306.821	6478.333	220.2328	261.8713	267.6139	192.9178	232.3322	237.1689

$^{aA...}$Means within columns bearing different superscripts differ significantly at: small letters – P≤0.05; capitals – P≤0.01.

whereas in the group "sold for breeding", it was about 7000 kg lower than in the Piech and Tarkowski [2002] report. The difference was caused by overall milk yield in the Pawlowice herd higher than the national mean as well as by the fact that "sale for breeding" from this herd was mainly due to low production. In the study of Piech and Tarkowski [2002], the lowest in lactation I was found for reproductive failures and the highest – for random events. It might have been caused by including in the random events (apart from the sudden deaths) various diseases and poor condition, in accordance with the classification of the Central Animal Breeding Office.

Pawlina *et al*. [1997] reported a level of production in the first three lactations similar to that reported in the present study. Cows with the highest milk yield left the herd mainly because of metabolic disorders – intensive production increased their susceptibility and health problems, what was also observed in the Pawlowice herd (Tab. 1). In this study, cows culled due to low production and sold for breeding were the lowest producing group. Pawlina *et al.* [1997] and Reklewski *et al.* [2004] reported the longest lifetime for cows culled because of age; however, the difference in relation to other groups was not found significant. The difference in the Pawłowice herd was highly significant because the oldest individuals lived, on average, longer (12.3 *vs*. 6.6 years) and produced more (50470 *vs*. 38584 kg milk). Mean lifetime milk yield was higher in cows analysed by Pawlina *et al.* [1997] than in the present population (17565 kg milk *vs*. 13670 kg), which might have been caused by the long time interval (98 years) covered by this report.

In the USA, health problems account for over 79% of cullings with the most significant role of injuries and reproduction disorders [Hadley *et al.* 2006]. Bascom and Young [1998] concluded that in the high-producing herds, culling for reproduction was more likely, whereas in the low-producing herds, the most common culling reasons were *mastitis* and low production. In recent years, unfavourable trends in culling decisions have been observed in the USA of earlier involuntary culling of highly-productive cows which shortens the period of their utilization and brings forward herd replacement [Weigel *et al.* 2003]. In the Finnish Ayrshire cattle, the highest producing cows were at the lowest risk of being culled and health problems (*mastitis*, lameness, teat injuries, milk fever) increased the risk of exiting [Rajala-Schultz and Grohn 1999]. At the same time, in French Holsteins, reproduction disorders and low production levels were the most significant risk factors [Seegers *et al*. 1998].

It can be concluded that in the herd examined for the period of 96 years (1909-2006), changes were observed in the period of keeping cows as well as in the yield of milk and its components. Apart from the discussed reasons of culling, it should be kept in mind that during a period of almost 100 years changes in the breeding programme took place and the rate of upgrading with the Holstein Friesian genes was also altered as indicated in the model.

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Wpływ przyczyn brakowania na wydajność życiową krów rasy polskiej holsztyńsko fryzyjskiej (czarno-białej) w gospodarstwie Pawłowice w latacg 1909-2006

S t r e s z c z e n i e

Badano związki między długością życia, przyczynami brakowania a wydajnością laktacyjną i życiową mleka i jego składników z zastosowaniem analizy wariancji z testem Duncana. Krowy o najwyższych wydajnościach życiowych mleka i jego składników były brakowane ze stada z powodów zdrowotnych. Osobniki o najniższej wydajności brakowano głównie z powodów behawioralnych oraz trudności w dojeniu (ciężki dój).