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LONGEVITY OF COWS DEPENDING ON THEIR FIRST LACTATION YIELD AND HERD PRODUCTION LEVEL*

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Abstract

The effect of first lactation yield and herd production level on longevity was studied using data from the SYMLEK database on 12045 Polish Holstein-Friesian cows in 1371 farms from the active population in Pomerania and Kujawy. The cows first calved in 2008 and were used or disposed from the herds by the end of 2015. FREQ, GLM and CORR procedures from the SAS package were used in the statistical calculations. The optimum level of first lactation milk from the viewpoint of longevity varies according to herd production level, which serves as a measure of the quality of rearing conditions. If the living conditions are not adapted to the high milk production of first calvers, there is a possibility that their productive life will be shortened and number of calvings decreased. The percentage of voluntary culling decisions by the breeder, which included the sale for further breeding, low milk yield and old age, averaged 9% and decreased with increasing herd production level from 16% to around 6%. The main reason for culling was infertility (around 40% on average). Culling due to infertility was particularly common among the cows which produced more than 11000 kg milk as first calvers.

Key words: cow, longevity, first lactation, production level

As the most important functional trait in cattle, longevity is crucial for breeding and production (Strapák et al., 2005; Brickell et al., 2010; Litwińczuk et al., 2016). Selection indices in many countries have a weighting of 40–50% on longevity traits (Pytlewski et al., 2010). Dairy cows are not allowed to live long enough because they are culled before their natural lifespan is over. Their milk production period has a decisive impact on milk production profitability (Żukowski, 2009). According to Ziętara et al. (2013), the optimum milk production period should, for economic reasons, range between five and eight lactations. Therefore, a productive period of around three lactations that has been reported recently (PFHBiPM, 2015), can be considered too short. Cows are usually culled from herds too early and as a result the productive life, that is too short, does not allow cows to show their full productive

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potential and subsequently fails to guarantee the reimbursement of costs (Forabosco et al., 2004; Sewalem et al., 2008; Cozler et al., 2008; Brickell and Wathes, 2011; Januś and Borkowska, 2012). Other consequences of shortened productive life include compromised welfare of the cows and, as a result, restrictions on selection of prospective dams, which causes substantial economic losses (Strapák et al., 2005; Brickell et al., 2010). An increase in length of productive life from 3 to at least 5 lactations would allow increasing the number of in-calf heifers reared for sale or the production of young beef in lieu of less valuable beef from culled dairy cows (Ziętara et al., 2013).

First lactation is considered as test lactation because the cows' body is still developing. First lactation yield is gaining in importance considering the long-persisting tendency for shortening the lifespan of cows (Sawa, 2011). Therefore, the problem of high first lactation yield in connection with the level of functional traits (including longevity) is of growing importance.

The aim of the study was to analyse the longevity of cows in herds with different production levels, depending on first lactation milk yield.

Material and methods

The study used data from the SYMLEK database. This consisted of 12045 production records on Polish Holstein-Friesian cows (Black-and-White variety) in 1371 farms from the active population in Pomerania and Kujawy. All cows in the data first calved in 2008 and were disposed from the herds by the end of 2015. The following longevity indicators were calculated:

– lifespan = culling date – birth date,
– length of productive life = culling date – date of first calving,
– number of calvings = total calvings.

The longevity of culled cows (lifespan (years), length of productive life (years), number of calvings) was analysed as the effect of herd production level and milk yield of first calvers and the interaction between them, using the following linear model (SAS, 2013):

$$Y = \mu + a_i + b_j + (ab)_{ij} + e_{ij}$$

where:

μ – overall mean,

a_i was the effect of ith herd production level (≤6000, 6001–7000, 7001–8000, 8001–9000 and >9000 kg milk),

b_j was the effect of jth milk yield of first calvers (≤7000, 7001–9000, 9001–11000 and >11000 kg milk),

$(ab)_{ij}$ was the interaction of herd production level × milk yield of first calvers,

e_{ij} was the random error of observation.

Significant differences were analysed with the Scheffe test.

Chi square test (SAS, 2013) was used to test for association between:

– herd production level or milk yield of first calvers and percentage of cows sold, culled, or surviving until the end of 2015,

– milk yield of first calvers in herds with different production levels and culling pattern, taking into account the reasons according to SYMLEK database (low milk yield, udder disease, infertility, reproductive diseases, infectious diseases (including leukemia), old age, metabolic and gastrointestinal diseases, respiratory diseases, locomotor system diseases, accidents, and others).

The CORR procedure (SAS, 2013) was used to estimate the correlation coefficients between the milk yield of first calvers in herds and different production levels as well as lifespan and length of productive life.

Results

The herd production level caused greater differences in the percentage of the cows sold, culled and alive compared to the milk yield of first calvers (Table 1). As the milk yield of first calvers increased, the proportion of cows sold and alive decreased ($P \leq 0.01$), and the proportion of culled cows increased. Among the cows which did not exceed 7000 kg milk, the proportion of cows sold was more than threefold higher than among their contemporaries yielding >11000 kg milk, while the proportion of surviving cows was over twice as high. Similar tendencies occurred for the effect of the increasing herd production level, with the proportion of cows sold from herds yielding ≤6000 kg milk being over 6 times as high as for cows from herds yielding 8000–9000 kg milk.

Table 1. Proportion of the cows sold, culled and alive

Factor	n/%	Proportion (%) of cows		
		sold	culled	alive
Yield of first calvers (kg milk) $\chi^2 = 184.11$ xx				
≤7000	4352/36.13	9.31	85.18	5.51
7001–9000	3337/27.70	5.42	89.36	5.21
9001–11000	2223/18.46	4.18	92.22	3.60
>11000	2133/17.71	2.72	94.84	2.44
Herd production level (kg milk) $\chi^2 = 411.93$ xx				
≤6000	2214/18.38	13.05	78.73	8.22
6001–7000	2719/22.57	6.07	88.67	5.26
7001–8000	2913/24.18	6.04	90.59	3.36
8001–9000	2044/16.47	1.96	95.79	2.25
>9000	2155/17.89	3.11	93.32	3.57
Total	12045	6.12	89.35	4.53

xx – $P \leq 0.01$.
n – number of cows.

Table 2. Effect of first lactation milk yield and herd production level on cow longevity

Longevity indicator	Herd production level (kg milk)	Yield of first calvers (kg milk)									Significance of differences
		≤7000		7001–9000		9001–11000		>11000		Total	1,2 – 5,9,13,17 xx
Lifespan (years)	≤ 6000	1*	5.62	2	5.83	3	5.90	4	5.46	5.70	3,6,7,8 – 9,13,17 xx
	6001–7000	5	5.16	6	5.83	7	5.60	8	5.53	5.53	4,14–16 – 17 xx
	7001–8000	9	4.71	10	5.59	11	5.58	12	5.47	5.34	5 – 6,13,17 xx,9,10 x
	8001–9000	13	3.93	14	5.37	15	5.44	16	5.33	5.02	9 – 10–20 xx; 10–12 – 13,17 xx
	>9000	17	3.45	18	5.37	19	5.56	20	5.46	4.96	13 – 14–16 xx; 18 – 20 xx
	Total	4.57		5.60		5.61		5.45			17 – 18–20 xx
Length of productive life (years)	≤ 6000	1	3.36	2	3.4	3	3.59	4	3.14	3.41	1,2,3,6,7 – 9,13,17 xx
	6001–7000	5	2.95	6	3.58	7	3.27	8	3.14	3.24	4,14–16 – 17 xx
	7001–8000	9	2.52	10	3.40	11	3.32	12	3.20	3.11	5 – 13,17 xx,6,10 x
	8001–9000	13	1.74	14	3.19	15	3.24	16	3.13	2.83	8,10–12 – 13,17 xx
	>9000	17	1.20	18	3.16	19	3.35	20	3.22	2.73	9 – 10–17 xx,19,20 xx,18 x
	Total	2.35		3.37		3.35		3.17			13 – 14–16 xx,18,20 xx
											17 – 18–20 xx
No. of calvings	≤ 6000	1	3.16	2	2.95	3	2.55	4	1.76	2.61	1 – 4,8,9,12,13,16,17,20 xx
	6001–7000	5	2.95	6	3.14	7	2.63	8	2.15	2.73	2,5 – 8,13,17 xx; 4 – 6,10,14,18,19 x
	7001–8000	9	2.70	10	3.15	11	2.86	12	2.36	2.77	6 – 8,12,13,16,17 xx; 7 – 10,17 xx
	8001–9000	13	2.05	14	3.06	15	3.01	16	2.51	2.66	8 – 10,14,15,18,19 xx; 9 – 10,13,17 xx; 10 – 12,13,16,17 xx;
	>9000	17	1.63	18	3.012	19	3.14	20	2.71	2.65	11 – 13,17 xx;
	Total	2.50		3.09		2.84		2.30			12 – 13,14,16–18 xx; 13 – 14,15,18–20 xx
											14,15 – 16,17 xx; 16 – 17–19 xx
											17 – 18–20x x

* – additional marking for reading the significance of differences.
x – P≤0.05, xx – P≤0.01.

As the herd production level increased, the lifespan and the length of productive life decreased (P≤0.01) by 0.74 and 0.68 years, respectively (Table 2). Differences in the lifespan and the length of productive life due to milk yield of first calvers were greater (by 0.88 and 0.82 years, respectively). The cows whose first lactation milk yield did not exceed 7000 kg had the shortest lifespan and productive life (4.57 and 2.35 years, respectively). It is significant that cow longevity improved with increasing milk yield of first calvers up to the level of 9001–11000 kg only (lifespan of 5.61 years and productive life of 3.35 years).

The number of calvings (2.77) was greatest in cows from herds yielding 7001–8000 kg milk, and it slightly decreased as the herd production level either increased or decreased. Analysis of the effect of first lactation milk yield on the number of calvings revealed that they were most numerous (3.09) in cows which yielded 7001–9000 kg milk as first calvers, whereas their lower and higher yielding contemporaries calved less frequently (cows with first lactation yield of >11000 kg milk had the lowest number of calvings, i.e. 2.3).

The interaction between first lactation yield and herd production level had a statistically significant effect (P≤0.01) on all the longevity indicators under analysis. The best level of first lactation yield of the cows in terms of longevity varied according to herd production level. For cows with first lactation yields of ≤7000 kg milk, the highest longevity indicators were found when they were used in herds with the lowest milk yield level of ≤6000 kg (Table 2). As the herd production level increased, the lifespan and the length of productive life, and the number of calvings decreased (P≤0.01) by 2.17 years and by 1.53 calvings, respectively. As regards the cows assigned to the other groups based on their first lactation yield, there was a tendency for these periods to shorten with increasing herd production level but the differences were much smaller (up to 0.46 year). The shortest lifespan (3.45 years) and productive life (1.20 years) were observed in highest producing cows which had the first lactation yield of ≤7000 kg milk. It is worth noting that for cows with first lactation yields of >11000 kg milk, the lifespan (around 5.45 years) and the length of productive life (around 3.17 years) were uniform regardless of the herd production level. Cows that produced 9001–11000 kg milk as first calvers had the longest lifespan, and their advantage in lifespan over their least productive contemporaries increased with herd production level, from 0.28 year (≤6000 kg) to 2.11 years (>9000 kg). A similar tendency was observed for the length of productive life.

In low-producing herds, cows that yielded 9001–11000 kg milk as first calvers had the longest lifespan and productive life. For both lower and higher producing first calvers, a decrease in longevity (by as much as 0.34 year in the lowest producing group) is to be expected. As the herd production level increased, so did (up to 2 years) the difference between the lifespan and productive life of the cows that produced 9001–11000 kg milk as first calvers, compared to the lowest producing contemporaries, and at the same time this difference decreased (from 0.44 to 0.13 years) in relation to the highest yielding contemporaries.

The herd production level caused differences (P≤0.01) in the longevity of cows measured as the number of calves born, with different tendencies in the groups that showed clear differences in the first lactation yield. For first calvers with lactational

yield of ≤7000 kg milk, the number of calves born was found to decrease (P≤0.01) as the herd production level increased. The number of calves born to cows with first lactation yields of ≥9001 kg milk increased with the increasing herd production level. In the lowest producing herds (≤6000 kg milk), cows with the lowest first lactation yield (≤7000 kg milk) had the highest number of calvings (3.16). As the milk yield of first calvers increased, the number of calvings decreased (to 1.76). In the highest producing herds (>9000 kg milk), cows with first lactation yields of 9001–11000 kg milk had the highest number of calvings (3.14), and in the other herds the highest number of calvings (about 3.1) occurred for cows with first lactation milk yields of 7001–9000 kg. Only 1.76 calvings during the lifetime of the cows that produced >11000 kg milk as first calvers and were used in herds with the production level of ≤6000 kg is evidence that these animals were improperly fed and cared for during the first lactation and that the environmental conditions were not adjusted to the needs of high producing animals. In turn, the fact that the number of calvings in cows that produced >11000 kg as first calvers, increased with the increasing herd production level, may result from the better selection of animals in these herds, better expertise of the stockpeople and veterinarians, and more balanced nutrition.

The relationship between the milk yield of first calvers and their longevity was determined using the coefficients of correlation, which for most of the cows amounted to about 0.18 xx for lifespan and length of productive life (Table 3). This relationship, considered for cows grouped according to herd production level, was clear but small (r=0.22 x) for the lowest production level, and increased (to r=0.26 xx) for the higher levels. The correlation coefficients presented in Table 3 show that longevity predicted from the milk yield of first calvers is inaccurate, especially in herds yielding ≤6000 kg milk.

Table 3. Coefficients of phenotypic correlation between milk yield of first calvers used in herds with different production levels and their longevity

Herd production level (kg milk)	n	Lifespan (years)	Length of productive life (years)
≤ 6000	1743	0.22 xx	0.21 xx
6001–7000	2411	0.26 xx	0.24 xx
7001–8000	2639	0.26 xx	0.25 xx
8001–9000	1958	0.23 xx	0.23 xx
>9000	2011	0.26 xx	0.26 xx

xx – P≤0.05.
n – number of cows.

Analysis of the culling patterns in cows is an important issue from a breeding and economic perspective. A statistically significant effect (P≤0.01) of the lactational performance of first calvers and the herd production level (except for lowest producing herds) on the level of culling due to various reasons was observed (Table 4). The milk yield of first calvers caused greater differences in the proportion of the cows than the herd production level.

Table 4. Effect of first lactation yield and herd production level on cow culling pattern

Herd production level (kg milk)	Yield of first calvers (kg milk)	n/%	Proportion (%) of cows culled due to									
			low yield	udder diseases	fertility and reproductive diseases	infectious diseases (including leukemia)	old age	metabolic and digestive diseases	respiratory diseases	diseases of the locomotor system	accidents	other
≤ 6000 χ2 = 2.11	≤ 7000	1241/71.2	1.45	14.18	38.92	0.24	1.45	7.57	0.24	7.25	12.65	16.04
	7001–9000	333/19.05	1.51	12.95	41.57	0.00	2.11	4.82	0.00	7.53	15.96	13.55
	9001–11000	128/7.34	0.00	10.94	46.88	0.00	2.34	10.16	0.00	4.69	11.72	13.28
	>11000	41/2.41	0.00	11.90	64.29	0.00	0.00	4.76	0.00	2.38	7.14	9.52
			1.32	**13.65**	**40.62**	**0.17**	**1.61**	**7.17**	**0.17**	**7.00**	**13.08**	**15.20**
6001–7000 χ2 = 149.57 xx	≤ 7000	1138/47.2	1.23	17.84	36.73	0.88	1.58	5.80	0.26	6.77	13.97	14.94
	7001–9000	744/30.86	0.40	13.84	42.74	0.00	1.61	5.11	0.27	6.18	14.52	15.32
	9001–11000	331/13.73	0.60	14.50	44.11	0.00	0.91	6.04	0.30	5.44	14.11	12.99
	>11000	198/8.21	0.00	13.13	49.49	0.00	0.00	8.82	0.00	7.84	10.20	4.11
			0.79	**15.76**	**40.65**	**0.41**	**1.37**	**5.64**	**0.25**	**6.35**	**14.64**	**14.14**
7001–8000 χ2 = 57.62 xx	≤ 7000	748/28.34	3.88	19.65	35.16	0.25	1.60	7.09	0.13	9.36	13.64	9.24
	7001–9000	955/36.19	1.99	15.29	39.06	0.00	0.63	10.37	0.21	9.84	12.36	10.26
	9001–11000	542/20.54	1.66	12.73	39.67	0.00	1.11	10.52	0.18	11.25	12.73	10.15
	>11000	394/14/93	1.27	9.90	47.22	0.00	0.25	8.38	0.25	9.39	14.47	7.87
			2.35	**15.20**	**39.45**	**0.00**	**0.95**	**9.17**	**0.19**	**9.93**	**13.11**	**9.66**
8001–9000 χ2 = 47.12 xx	≤ 7000	312/15.93	3.85	18.59	26.28	0.32	0.32	8.97	0.64	10.90	15.38	14.74
	7001–9000	547/27.94	2.38	12.80	40.22	0.18	1.10	12.43	0.91	8.96	10.24	10.79
	9001–11000	530/27.07	2.45	14.72	34.72	0.00	0.94	11.13	1.13	9.62	15.09	10.19
	>11000	569/29.06	1.23	15.11	41.12	0.00	1.05	9.67	1.05	8.61	10.72	11.42
			2.30	**14.91**	**36.77**	**0.10**	**0.92**	**10.73**	**0.97**	**9.35**	**12.51**	**11.44**
>9000 χ2 = 85.29 xx	≤ 7000	268/13.33	5.22	22.76	20.52	0.37	0.37	11.19	0.00	11.57	18.66	9.33
	7001–9000	404/20.09	2.72	14.60	43.07	0.00	0.74	10.15	0.25	8.66	12.13	7.67
	9001–11000	519/25.81	0.96	13.68	39.31	0.00	0.77	12.52	0.96	9.44	12.72	9.63
	>11000	820/40.78	0.85	13.66	43.05	0.12	1.10	10.49	0.49	9.02	12.56	8.66
			1.84	**15.07**	**39.09**	**0.10**	0.85	11.04	0.50	9.40	13.33	8.80

xx – P≤0.01.
n – number of cows.

Regardless of the class of both factors, the most common culling reasons were infertility and reproductive diseases. Within individual herd production levels, the proportion of cows culled for these reasons increased with the increasing milk yield of first calvers. For example, it increased from 38.92% to 64.29% in herds with the production level of ≤6000 kg, and from 20.52% to 43.05% in herds producing ≥11000 kg milk.

The second most frequent reason for culling, regardless of the herd production level, were udder diseases. The proportion of cows culled for this reason ranged from 13.65% in low-producing herds (<6000 kg) to 15.76% in herds producing 7001–9000 kg milk. It is worth noting that regardless of the herd production level, the proportion of culled cows decreased with the increasing milk yield of first calvers, with the highest increase in herds producing ≥11000 kg milk (by 22.76% to 13.66%).

Accidents were the third most frequent reason for culling, and within herd production levels there were no tendencies for the increasing milk yield of first calvers to be paralleled by an increase or decrease in the proportion of cows culled for this reason.

The tendency for the proportion of cows culled for low milk yield to increase with the increasing herd production level is suggestive of appropriate breeding work. Regardless of the herd production level, the proportion of cows culled for low milk yield decreased with the increasing lactational performance of first calvers.

The fact that the proportion of cows culled for old age decreased (from 1.61% to 0.85%) with the increasing herd production level confirms the better longevity of cows used in low-producing herds, as shown in Table 2.

The increase in the herd production level, especially beyond 7000 kg milk, was accompanied by an increase in the proportion of cows culled for metabolic diseases. Regardless of the herd production level, the proportion of cows culled for metabolic diseases increased with the first lactation milk yield increasing to 11000 kg. It may be conjectured that regardless of the herd production level, most attention was directed towards feeding the highest producing cows (>11000 kg).

As the herd production level increased, so did the proportion of cows culled for respiratory and locomotor system diseases, and within herd production levels there were no tendencies for the increasing milk yield of first calvers to be paralleled by an increase or decrease in the proportion of cows culled for these reasons.

Discussion

The average lifespan of the cows was 5.36 years (3.12 years for length of productive life) and was similar to that reported by the Polish Federation of Cattle Breeders and Dairy Farmers (PFHBiPM, 2015) and other authors (Chabuz et al., 2016). Sawa (2011), in summing up the results of studies on cow longevity, performed in national research centres in late 20th and early 21st centuries, concluded that the lifetime of cows averaged from 4.5 to 6.6 years, and the length of productive life averaged from

2.8 to 4.6 years. According to the PFHBiPM reports, the cows' milk production period has not undergone any significant changes.

The average number of calvings was 3.11. As is evident from the studies on milk yield in successive lactations (Sawa, 2001), cows should not be culled before the 3rd–5th lactations, after reaching the cows' maximum performance. Juszczak et al. (2003) demonstrated that the cost of milk produced together by the cows used for three lactations only is equal to its market value, and profits can be obtained only for cows that are used for longer. This view is shared by Kancer et al. (2001), according to whom it is profitable to use cows for at least four lactations. Data suggest that 59% of cows were culled before their fourth parity (Bell et al., 2010). According to Rocha et al. (2010), only 15% of Portuguese Holstein-Friesians enter their fourth lactation. The problem with the length of productive life was also reported by Brickell and Wathes (2011), who showed that 43% of cows are slaughtered before their third calving. The fact that cows are culled more intensely before reaching peak milk yields was underlined by Strapák et al. (2005), Dorynek et al. (2006) and Brickell et al. (2010). The decreased number of parturitions implies that cows remain in the herd for less time, which has a direct effect on milk production profitability (Forabosco et al., 2004; Sewalem et al., 2008).

Our results (Table 2) and those of other authors (Różańska-Zawieja et al., 2008; Borkowska and Januś, 2009; Sawa and Krężel-Czopek, 2009; Pytlewski et al., 2010; Januś and Borkowska, 2012) show that the lifespan and the length of productive life depend on first lactation yield of the cows. Considering the short lifespan of the cows, it can be stated that the high first lactation yield has a positive effect on longevity. However, the excessively high milk yield of first calvers (>11000 kg) was found to shorten the lifespan and the length of productive life, as well as reducing the number of calvings. This is particularly evident in herds with a lower level of production, which may be the consequence of inadequate conditions of maintenance in relation to the high level of primiparous performance. It is worth noting that similar tendencies were described in earlier research, which stressed that the efforts to maximize first lactation yield may significantly reduce the length of the productive period, and according to Juszczak et al. (1994), the length of the productive period was shortened when first lactation yield exceeded 5000 kg milk; in later studies, this level was >7000 kg milk (Sawa and Krężel-Czopek, 2009) and >9000 kg milk (Ziętara et al., 2013). According to Pytlewski et al. (2010) the longest lifespan (5.53 years) was found for cows with the lowest first lactation yield of below 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. The positive correlation between first lactation yield and longevity was also noted by Strapák et al. (2005) (r=0.4) and Sadek et al. (2009) (r=0.2), as well as Tekerli and Koçak (2009) (r=0.08). Correlations between milk yields and longevity ranged from 0.53 to –0.29 according to the countries that input international longevity evaluations (Powell and Van Raden, 2003).

One of the most important decisions to be made by a breeder concerns removal of a cow from the herd. According to Reklewski et al. (2004), from the perspective of the economic aspects of production, sound reasons for culling include low productiv-

ity and possibly sale of animals suitable for further rearing, as well as old age. Our findings (Table 1 and 4) show that both factors have an effect ($P \leq 0.01$) on the proportion of cows culled for reasons dependent on the breeder. The increase in milk yield of first calvers and herd production level caused more than three-fold and a two-fold decrease in the proportion of cows sold for further rearing respectively (Table 1). The relatively high proportion (13.05%) of the cows sold from the lowest producing herds seems to be related to the unprofitability of milk production, but may also be suggestive of appropriate breeding work. Of concern is the small (1.7% on average) proportion of cows culled for low milk yield, and even the observed tendency for the increased proportion of the cows culled for this reason with the increasing herd production level (Table 4) gives no ground to limit selection due to the low milk production. Morek-Kopeć and Żarnecki (2009) showed the proportion of cows culled for low milk yield to decrease from 7.4% (1995–2002) to 3.6% (2003–2007).

Analysis of the literature on cow losses points to the problem of an increasing number of cullings for reasons beyond breeders' control (Reklewski et al., 2004; Morek-Kopeć and Żarnecki, 2009; Sawa, 2011). Likewise, Sawa (2001) and Januś and Borkowska (2012) revealed a significant effect of first lactation yield on the proportion of cows culled for various reasons (Table 4). Our findings, similar to the results of other authors, indicate that the main reason for removal of cows from the herds was infertility (Morek-Kopeć and Żarnecki, 2009; Sawa and Bogucki, 2009; Januś and Borkowska, 2012). Morek-Kopeć and Żarnecki (2009), based on data from the SYMLEK system concerning 1,441,446 cows culled in 1995–2007 observed an upward tendency for culling due to infertility and reproductive diseases. Sawa and Maciejewski (2000) showed a clear increase in culling for infertility in higher producing herds. Januś and Borkowska (2012) demonstrated that the increasing yield in first lactation was paralleled by increased culling for infertility. This results from the high nutritional requirements that are hard to meet, and also from the fact that supplied nutrients are in the first place used for maintenance requirements and for milk production. This leads to competition between milk yield and fertility (Strucken et al., 2012). The excessive emaciation of animals may lead to metabolic changes that adversely affect reproductive parameters resulting from functional changes of the reproductive tract (Jaśkowski et al., 2006) and translate into reduced conception rates and increased likelihood of pregnancy loss (Herlihy et al., 2013), which results in culling.

Another major reason for culling in our study were udder diseases, which eliminated from 13.65% of cows in lowest producing herds (<7000 kg) to 15.76% in herds with milk production levels of 7001–9000 kg. Attention was also called to the fact that regardless of the herd production level, the proportion of cows culled for this reason decreased with increasing milk yield of first calvers, most of all in herds producing ≥11000 kg milk (from 22.76% to 13.66%). Morek-Kopeć and Żarnecki (2009) showed the frequency of culling for this reason to increase during 1995–2007 from 4.45% to over 11%, which may be attributed to the growing milk quality requirements demanded from milk producers.

A major reason for culling was accidents (13.38% on average), but within herd production levels there was no tendency for the increasing yield of first calvers to be

paralleled by an increase or decrease in the proportion of cows culled for this reason. In practice, accidents are hard to eliminate, although they are primarily dependent on the breeder. Dorynek et al. (2006) attribute the high proportion of accidents among the reasons for culling dairy cows to the fact that this term is used to replace all the other culling reasons that have not been specified in the SYMLEK system, or to unreliable breeding records.

Almost 9% of the cows were culled for metabolic and gastrointestinal diseases, as much as 11% of which came from herds with milk production levels exceeding 8000 kg. According to Studziński et al. (2003), there is an increasing incidence of losses due to metabolic disorders in the periparturient period, which eliminates from 15 to over 40% of the cows in high-yielding herds from further rearing. Heavy milkers are predisposed to using their own energy reserves, in particular the adipose tissue (Strucken et al., 2012; Bisinotto et al., 2012), but in some cases also the muscle tissue (Strucken et al., 2012) and to the increased use of amino acids, minerals and vitamins (Bisinotto et al., 2012) in the critical initial period of lactation. It is estimated that despite breeders' efforts, metabolic and infectious diseases during the first months of lactation affect 45–60% of the cows regardless of milk yield level, breed, and herd management system (Bisinotto et al., 2012).

Conclusions

The present analysis allows a conclusion that the optimum level of first lactation yield from the viewpoint of longevity varies according to herd production level, which serves as a measure of the quality of rearing conditions. If the living conditions are not adapted to the high milk production of first calvers, there is a possibility that their productive life will be shortened and number of calvings decreased. It is of concern that the percentage of voluntary culling decisions by the breeder, which include the sale for further breeding, low milk yield and old age, was only 9% and decreased with increasing herd production level from 16% to around 6%. The main reason for culling was infertility (around 40% on average), and culling due to infertility was particularly common among the cows which produced more than 11000 kg as first calvers. Considering the proportion of cows culled for metabolic diseases, it was concluded that regardless of the herd production level, most attention was paid to feeding highest producing cows (>11000 kg).

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