

## **EFFECT OF CERTAIN FACTORS ON THE LONGEVITY AND CULLING OF COWS**

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**Abstract.** This study involved 1072 Polish Holstein-Friesian cows that were raised in 12 farms of the Kujawsko-Pomorskie province and culled between 2000 and 2012. Statistical calculations accounted for the effect of certain factors (age of cow at first calving, production level in the first lactation, housing system, herd size) on cow longevity (lifespan, length of productive life, number of calvings) and lifetime performance (GLM procedure of SAS) and proportion of culled cows (FREQ procedure of SAS). Increasing cow herd size had a negative effect ( $P \leq 0.01$ ) on longevity and lifetime performance. Likewise, efforts to maximize first lactation milk yield ( $> 10\,000$  kg milk) may shorten ( $P \leq 0.05$ ) the lifespan of the cows. Among the culled cows, as much as 90% were culled for reasons unplanned by breeders. Alarmingly, culling levels were particularly high (92%) in the largest herds ( $> 100$  cows). Cows were culled mainly for infertility, and this reason for culling was particularly noticeable in cows that were oldest at first calving ( $> 30$  months of age); yielded more than 10 000 kg of milk as primiparous cows; and were used in herds of 51–100 cows.

**Key words:** cows, culling, determinants, Holstein-Friesian, longevity

### **INTRODUCTION**

Longevity is considered one of the most important indicators of cow production efficiency [Zdziarski et al. 2002, Juszczak et al. 2003, Sobek et al. 2005], as evidenced by its inclusion in the new selection index (PFHBiPM 2014).

Longevity can be measured in terms of lifespan (from birth to culling from the herd) or length of productive life (from first calving to culling) [Sawa 2011].

Many studies indicate that cows in Poland are culled prematurely, having a lifespan of about 6 years on average [Róžańska-Zawieja et al. 2008, Sawa 2011]. The potential for increased cow longevity is of particular interest for breeders. Róžańska-Zawieja et al. [2008] found that the lifespan of cows is highly significantly influenced by factors such as breed, farm, diet, reason for removal, maximum lactation number, maximum lactation length, and lifetime milk and milk constituents yield. Other factors include productivity [Reklewski et al. 2004], age at first calving [Gnyp et al. 2006], and housing system [Zdziarski et al. 2002, Sawa et al. 2008]. A cow's lifespan is inextricably linked to its health, production level, reasons for culling, and culling intensity [Varisella et al. 2007]. According to Żukowski [2009], culling cows from the herd is one of the more important, if not the most important part of costs which has an effect on milk production profitability.

The objective of the study was to analyse the effect of certain factors on longevity and culling of cows.

## MATERIAL AND METHODS

The study was carried out in 12 farms of the Kujawsko–Pomorskie province. Subjects were 1072 Polish Holstein-Friesian cows of Black-and-White variety that were culled between 2000 and 2012.

The following data on each cow were obtained from breeding records: date of birth, consecutive calving dates, evaluation withdrawal date, first lactation and lifetime milk yield, and reason for culling, taking account of the following reasons specified by the SYMLEK database: 06 – sold for further breeding, 07 – low productivity, 08 – udder diseases, 09 – infertility and reproductive diseases, 10 – infectious diseases (including leukemia), 11 – old age, 12 – metabolic and gastrointestinal diseases, 13 – respiratory diseases, 14 – locomotor system diseases, 15 – accidents, 16 – other.

In the statistical calculations, we analysed the effect of some factors (age at first calving:  $\leq 22$ , 22.1–24, 24.1–26, 26.1–28, 28.1–30 and  $> 30$  months; milk production level in the first lactation:  $\leq 5000$ , 5001–10 000 and  $> 10\ 000$  kg; housing system: tie-stall vs. loose; and herd size:  $\leq 50$ , 51–100 and  $> 100$  cows) on cow longevity (lifespan: date of culling – date of birth), length of productive life (date of culling – date of first calving, number of calvings), lifetime performance (GLM procedure of SAS, 2013) and proportion of cows culled for different reasons (FREQ procedure of SAS, 2013).

## RESULTS AND DISCUSSION

On average, the analysed cows had a lifespan of 5.1 years and a productive life of 3.1 years, calved 3.39 times, and had a lifetime production of 20 187 kg milk. These results do not differ from those reported by Sawa [2011], which show that over the last 20 years the average lifespan of cows ranged from 4.5 to 6.6 years, with length of productive life varying between 2.8 and 4.6 years.

The age of cows at first calving had no significant effect on longevity (Table 1). From an economic perspective, the optimal age at first calving is considered to range between 22 and 24 months. The cows that calved during this period were characterized by the highest performance and the greatest number of calvings. According to Sobek et al. [2006], the lifespan of cows can be slightly increased in proportion to their age at first calving ( $r = 0.101^{**}$ ).

Table 1. Factors affecting longevity and lifetime performance of the cows

Tabela 1. Czynniki wpływające na długowieczność i wydajność życiową krów

| Factor<br>Czynniki   | No. of cows<br>Liczba krów | Lifespan, years<br>Długość życia,<br>lat | Length of productive<br>life, years<br>Długość<br>użytkowania, lat | No. of calvings<br>Liczba wycieleń | Lifetime milk<br>performance, kg<br>Wydajność<br>życiowa, kg |
|--|----------------------------|--|--|------------------------------------|--|
| Age at first calving, months<br>Wiek pierwszego wycielenia, miesiące       |                            |  |  |                                    |  |
| < 22   | 41                         | 4.42                                     | 3.04   | 3.15                               | 22754  |
| 22.1–24  | 156                        | 5.00                                     | 3.19   | 3.50                               | 23344  |
| 24.1–26  | 313                        | 4.88                                     | 3.06   | 3.19                               | 20426 a  |
| 26.1–28  | 166                        | 5.54                                     | 3.24   | 3.48                               | 19998  |
| 28.1–30  | 109                        | 4.93                                     | 2.94   | 3.08                               | 18061  |
| > 30   | 159                        | 5.10                                     | 2.74   | 2.77                               | 15523 a  |
| First lactation milk yield, kg<br>Wydajność mleka w pierwszej laktacji, kg |                            |  |  |                                    |  |
| ≤ 5000   | 453                        | 4.95                                     | 3.01   | 3.32 A                             | 15855 AB   |
| 5001–10 000  | 409                        | 5.25 a                                   | 3.33   | 3.40 B                             | 24142 A  |
| > 10 000   | 86                         | 4.43 a                                   | 2.43   | 2.32 AB                            | 23823 B  |
| Housing system<br>System utrzymania  |                            |  |  |                                    |  |
| Tie-stall<br>Uwięziowy   | 412                        | 5.07                                     | 3.07   | 3.50                               | 18312 A  |
| Loose<br>Wolnostano-<br>wiskowy  | 660                        | 5.11                                     | 3.12   | 3.43                               | 21361 A  |
| No. of cows in herd<br>Liczba krów w stadzie                               |                            |  |  |                                    |  |
| ≤ 50   | 233                        | 5.91 AB                                  | 4.04 AB  | 4.32 AB                            | 28463 AB   |
| 51–100   | 369                        | 4.99 A                                   | 3.22 AC  | 3.40 AC                            | 20508 AC   |
| > 100  | 470                        | 4.81 B                                   | 2.49 BC  | 2.91 BC                            | 15919 BC   |

Means with the same letters differ significantly: capital letters at  $P \leq 0.01$ , small letters at  $P \leq 0.05$ .

Wartości średnie cech oznaczone tymi samymi literami różnią się statystycznie istotnie: dużymi przy  $P \leq 0,01$ , małymi przy  $P \leq 0,05$ .

In another study, Sobek et al. [2005] found the age at first calving to have no effect on longevity based on non-significant coefficients of correlation. Likewise, Brzozowski et al. [2001] reported that age at first calving had no significant effect on the length of productive life.

Table 2. Relationship between age at first calving and culling level

Tabela 2. Zależność między wiekiem krów przy pierwszym ocieleniu a poziomem ich ubycia

| Reason for removal<br>Powód ubycia   | Proportion of culled cows depending on age at first calving, months<br>Wiek krów przy pierwszym wycieleniu, miesiące |         |         |         |         |       | N<br>%       |
|--|--|---------|---------|---------|---------|-------|--------------|
|  | ≤ 22   | 22.1–24 | 24.1–26 | 26.1–28 | 28.1–30 | > 30  |              |
| Sold for further breeding<br>Sprzedaż do dalszego chowu                              | 2.44   | 0.64    | 6.96    | 9.52    | 4.55    | 5.66  | 54<br>5.68   |
| Low productivity<br>Niska wydajność  | 0  | 5.10    | 1.90    | 1.19    | 0       | 0.63  | 17<br>1.79   |
| Udder diseases<br>Choroby wymienia   | 31.71  | 16.56   | 16.46   | 16.07   | 22.73   | 25.16 | 183<br>19.24 |
| Infertility and reproductive diseases<br>Jałowość i choroby układu rozrodczego       | 31.71  | 37.58   | 38.61   | 29.76   | 40.00   | 42.77 | 356<br>37.43 |
| Infectious diseases, including leukemia<br>Choroby zakaźne w tym białaczka           | 0  | 0       | 3.80    | 3.57    | 5.45    | 5.03  | 32<br>3.36   |
| Old age<br>Starość   | 0  | 1.27    | 2.22    | 2.98    | 0       | 1.26  | 16<br>1.68   |
| Metabolic and gastrointestinal diseases<br>Choroby metaboliczne i układu pokarmowego | 7.32   | 6.37    | 3.80    | 4.17    | 06.36   | 3.14  | 44<br>4.63   |
| Locomotor system diseases<br>Choroby układu ruchu                                    | 2.44   | 7.01    | 4.75    | 2.98    | 2.73    | 1.26  | 37<br>3.89   |
| Accidents<br>Wypadki losowe  | 21.95  | 22.29   | 19.62   | 25.00   | 16.36   | 13.21 | 187<br>19.66 |
| Other<br>Inne  | 2.44   | 3.18    | 1.90    | 4.76    | 1.82    | 1.89  | 25<br>2.64   |
| Total (cows)<br>Razem (krowy)  | 41   | 157     | 316     | 168     | 110     | 159   | 951<br>100   |

\*\*  $P \leq 0.01$ .

First lactation milk yield had a significant ( $P \leq 0.05$ ) effect on the lifespan of the cows (Table 1). The cows that yielded 5001–10 000 kg of milk as first calvers had the longest lifespan and productive life. Compared to the cows with lower and higher milk yields, they were also superior in terms of the number of calvings and lifetime milk yield ( $P \leq 0.01$ ). The cows that produced 5001–10 000 kg of milk as first calvers had a 0.3 year longer lifespan and productive life and yielded an average of 8287 kg (about 52%) more milk during their lifetime compared to their contemporaries that produced less than 5000 kg of milk in the first lactation. A further increase in the milk yield of first calvers ( $> 10\ 000$  kg of milk) had a negative effect on longevity and lifetime performance. Also other authors [Różańska-Zawieja et al. 2008, Borkowska and Januś 2009, Sawa and Krężel-Czopek 2009] report that milk production life depends on first lactation milk yield while also

noting that the efforts to maximize milk yields during the first lactation may significantly shorten the productive life of the cows. According to Brzozowski et al. [2003], first lactation milk yield has no effect on the productive life of cows in the herd.

Table 3. Relationship between first lactation milk yield and culling level

Tabela 3. Zależność między wydajnością mleka krów w pierwszej laktacji a poziomem ich ubycia

| Reason for culling<br>Powód ubycia   | First lactation milk yield, kg<br>Wydajność mleka w pierwszej laktacji, kg |             |          | N<br>%       |
|--|--|-------------|----------|--------------|
|  | ≤ 5000   | 5001–10 000 | ≥ 10 000 |              |
|  | chi <sup>2</sup> =48.96**  |             |          |              |
| Sold for further breeding<br>Sprzedaż do dalszego chowu                              | 8.81   | 3.8         | 0        | 58<br>5.88   |
| Low productivity<br>Niska wydajność  | 2.52   | 1.66        | 0        | 19<br>1.93   |
| Udder diseases<br>Choroby wymienia   | 22.01  | 17.1        | 15.91    | 191<br>19.37 |
| Infertility and reproductive diseases<br>Jałowość i choroby układu rozrodczego       | 35.01  | 38.95       | 39.77    | 366<br>37.12 |
| Infectious diseases, including leukemia<br>Choroby zakaźne w tym białaczka           | 4.19   | 3.09        | 0        | 33<br>3.34   |
| Old age<br>Starość   | 2.1  | 1.43        | 0        | 16<br>1.62   |
| Metabolic and gastrointestinal diseases<br>Choroby metaboliczne i układu pokarmowego | 3.98   | 5.23        | 3.41     | 44<br>4.46   |
| Locomotor system diseases<br>Choroby układu ruchu                                    | 2.31   | 5.7         | 4.55     | 39<br>3.96   |
| Accidents<br>Wypadki losowe  | 17.61  | 19.48       | 31.82    | 194<br>19.68 |
| Other<br>Inne  | 1.47   | 3.56        | 4.55     | 26<br>2.64   |
| Total (cows)<br>Razem (krowy)  | 477  | 421         | 88       | 986<br>100   |

\*\*  $P \leq 0.01$ .

Cattle, especially cows, are raised under different housing systems. The housing system had no significant influence on longevity, whereas the lifetime performance of cows was 3049 kg milk higher ( $P \leq 0.01$ ) in free-stall compared to tie-stall barns. Likewise, Brzozowski et al. [2003] found the housing system to have no considerable effect on the lifespan and productive life of the cows. Sawa et al. [2008] observed that cows in tie-stall barns had a slightly longer productive life compared to cows in free-stall barns (3.26 vs. 3.14 years). According to Zdziarski et al. [2002], cows were used for 3.48 years in tie-stall barns and for 3.78 years in free-stall barns.

There was a statistically significant ( $P \leq 0.01$ ) effect of herd size on longevity and lifetime performance of the cows. The longest lifespan was in herds of  $\leq 50$

cows (5.91 years), followed by herds of 51–100 cows (4.99 years) and herds of > 100 cows (up to 4.81 years). A similar tendency was observed for the other indicators of longevity, namely length of productive life and number of calvings. Lifetime performance decreased as herd size increased. This may be related to the fact that cows are taken better care of in smaller herds, whereas in larger herds technological groups are the smallest units. Lifetime productivity of the cows culled from the smallest herds was the highest (28 463 kg). Also other authors [Sawa et al. 2000, Wroński et al. 2003] concluded that smaller herds achieve better longevity and lifetime productivity compared to large herds, attributing this to the individual approach to the cow and the fact that cows in small barns are taken better care of than in more mechanized large barns.

Table 4. Relationship between cow housing system and culling level

Tabela 4. Zależność między systemem utrzymania krów a przyczynami ich brakowania

| Reason for culling<br>Powód ubycia   | Housing system<br>System utrzymania |                            | N<br>%       |
|--|-------------------------------------|----------------------------|--------------|
|  | tie-stall<br>uwięziowy              | loose<br>wolnostanowiskowy |              |
|  | chi <sup>2</sup> = 40.32**          |                            |              |
| Sold for further breeding<br>Sprzedaż do dalszego chowu                              | 6.55                                | 5.00                       | 60<br>5.60   |
| Low productivity<br>Niska wydajność  | 1.21                                | 2.27                       | 20<br>1.87   |
| Udder diseases<br>Choroby wymienia   | 27.18                               | 15.61                      | 215<br>20.06 |
| Infertility and reproductive diseases<br>Jałowość i choroby układu rozrodczego       | 38.35                               | 37.12                      | 403<br>37.59 |
| Infectious diseases, including leukemia<br>Choroby zakaźne w tym białaczka           | 3.64                                | 2.73                       | 33<br>3.08   |
| Old age<br>Starość   | 0.49                                | 2.58                       | 19<br>1.77   |
| Metabolic and gastrointestinal diseases<br>Choroby metaboliczne i układu pokarmowego | 4.37                                | 5.30                       | 53<br>4.94   |
| Locomotor system diseases<br>Choroby układu ruchu                                    | 2.18                                | 4.70                       | 40<br>3.73   |
| Accidents<br>Wypadki losowe  | 14.08                               | 21.52                      | 200<br>18.66 |
| Other<br>Inne  | 1.94                                | 3.18                       | 29<br>2.71   |
| Total (cows)<br>Razem (krowy)  | 412                                 | 660                        | 1072<br>100  |

\*\* P ≤ 0.01.

All of the experimental factors had a significant ( $P \leq 0.01$ ) effect on the level of culling for different reasons (Tables 2–5). Regardless of the class of these factors, cows were most often culled due to infertility and reproductive diseases. Similarly, other authors [Jankowska 2002, Sobek et al. 2005, Varisella et al. 2007, Morek-Kopec and Żarnecki 2009] pointed to reproductive problems as the main

reason for removal of cows from the herd. Based on SYMLEK data for 1 441 446 cows culled between 1995 and 2007, Morek-Kopeć and Żarnecki [2009] found an upward tendency for culling due to infertility and reproductive disorders.

Regardless of the age at first calving, cows were most often culled for infertility and reproductive diseases, and the proportion of cows culled for this reason tended to increase with greater age at first calving (Table 2). Likewise, Sobek et al. [2005] reported the proportion of cows culled for infertility to be dependent on age at first calving. According to Jankowska [2002], culling due to infertility was most frequent in cows that first calved before 27 months of age.

Table 5. Relationship between cow herd size and culling level

Tabela 5. Zależność między liczbą krów w stadzie a poziomem ich ubycia

| Reason for culling<br>Powód ubycia   | No. of cows                 |        |       | N<br>%       |
|--|-----------------------------|--------|-------|--------------|
|  | ≤ 50                        | 51–100 | > 100 |              |
|  | chi <sup>2</sup> = 138.37** |        |       |              |
| Sold for further breeding<br>Sprzedaż do dalszego chowu                              | 2.58                        | 7.05   | 5.96  | 60<br>5.60   |
| Low productivity<br>Niska wydajność  | 2.58                        | 1.90   | 1.49  | 20<br>1.87   |
| Udder diseases<br>Choroby wymienia   | 21.46                       | 16.80  | 21.91 | 215<br>20.06 |
| Infertility and reproductive diseases<br>Jałowość i choroby układu rozrodczego       | 30.90                       | 46.34  | 34.04 | 403<br>37.59 |
| Infectious diseases, including leukemia<br>Choroby zakaźne w tym białaczka           | 0                           | 4.88   | 3.19  | 33<br>3.08   |
| Old age<br>Starość   | 5.15                        | 1.63   | 0.21  | 19<br>1.77   |
| Metabolic and gastrointestinal diseases<br>Choroby metaboliczne i układu pokarmowego | 7.30                        | 2.98   | 5.32  | 53<br>4.94   |
| Locomotor system diseases<br>Choroby układu ruchu                                    | 5.58                        | 4.34   | 2.34  | 40<br>3.73   |
| Accidents<br>Wypadki losowe  | 14.59                       | 13.28  | 24.89 | 200<br>18.66 |
| Other<br>Inne  | 9.87                        | 0.81   | 0.64  | 29<br>2.71   |
| Total (cows)<br>Razem (krowy)  | 233                         | 369    | 470   | 1072<br>100  |

\*\* P ≤ 0.01.

In our study, the other reasons for culling were accidents (19.7%) and udder diseases (19.2%). It is noticeable that cows that first calved at ≤ 22 and after 30 months of age were more frequently culled (31.7 and 25.2%) for udder diseases than the other cows. The other reasons for culling were relatively rare and there was no tendency for the proportion of cows culled for this reason to increase or decrease with greater age at first calving.

The increase in first lactation milk yield was paralleled by a decrease in the proportion of cows culled for low productivity, udder disorders, infectious diseases and old age, those sold for further breeding, and an increase in the proportion of cows culled for locomotor disease, accidents and other (Table 3).

Sale for further breeding, low productivity and old age are among the reasons for culling planned by the breeders. The relatively high proportion of cows with first lactation milk yield of  $\leq 5000$  kg milk (13.43%), compared to the other groups, which were culled for reasons planned by the breeders, is indicative of appropriate breeding work. All the cows that produced more than 10 000 kg milk in the first lactation were culled for reasons unplanned by the breeders, and were more often culled than others due to infertility and reproductive diseases, locomotor diseases, and accidents. In the present study, the high proportion of cows culled for infertility (over 40% in the group of cows with highest first lactation milk yields) confirms the well-known negative effect of high milk yield on cow fertility [Juszczak et al. 2003, Varisella et al. 2007, Oler et al. 2012].

When analysing the effect of housing system on the level of culling for different reasons (Table 4), it was found that compared to loose-housed cows, those housed in tie-stall barns were more often culled for udder diseases (almost twice as often), sold for further breeding, infertility and reproductive diseases, and infectious diseases. Old age, locomotor system diseases, accidents and low productivity were the more frequent causes of culling loose-housed cows. The higher proportion of the cows culled for old age, found in the loose housing system, concurs with the data presented in Table 1, which provide evidence that under this system cows have greater longevity. Sawa et al. [2008] demonstrated that the main reasons for culling were infertility (30.8% in tie-stall barns and 25% in free-stall barns), accidents (17 and 24%, respectively) and udder diseases (10 and 15%, respectively). According to Dorynek et al. [2006], regardless of the housing system, the main reasons for culling the cows were infertility followed by accidents and low productivity.

Independently of the number of cows in the herd, the most frequent reasons for culling were infertility and reproductive diseases, followed by udder diseases in barns with  $\leq 50$  and 51–100 cows and accidents in the largest barns (it is possible that in large herds, this was an all-inclusive term for all the other culling reasons that were not specified in the SYMLEK system, or breeding records were less reliable). It was found that an increase in stocking density was paralleled by a decrease in the proportion of cows culled for low productivity (1.7-fold), old age (24-fold), locomotor diseases (2.4-fold) and other reasons (15-fold).



## CONCLUSIONS

The increasing cow herd size had a negative effect ( $P \leq 0.01$ ) on longevity and lifetime performance. Likewise, efforts to maximize first lactation milk yield ( $> 10\,000$  kg milk) may shorten ( $P \leq 0.05$ ) the lifespan of the cows. Among the culled cows, as much as 90% were removed from the herds for reasons unplanned by breeders. It is of concern that culling levels were particularly high (92%) in the largest herds ( $> 100$  cows). Cows were culled mainly for infertility, and this culling reason was particularly noticeable in cows that were oldest at first calving ( $> 30$  months of age); yielded more than 10 000 kg of milk as primiparous cows; or were used in herds of 51–100 cows.

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## **WPLYW WYBRANYCH CZYNNIKÓW NA DŁUGOWIECZNOŚĆ I BRAKOWANIE KRÓW**

**Streszczenie.** Badaniami objęto 1072 krowy wybrakowane w latach 2000–2012, utrzymywane w 12 gospodarstwach województwa kujawsko-pomorskiego, użytkujących krowy rasy polskiej holsztyńsko-fryzyjskiej odmiany czarno-białej. W obliczeniach statystycznych uwzględniono wpływ wybranych czynników (wiek krowy w dniu pierwszego wycielenia, poziom wydajności w pierwszej laktacji, system utrzymania i liczebność stada) na długowieczność krów (długość życia, długość użytkowania, liczbę wycieleń) i ich wydajność życiową (procedura GLM z pakietu SAS (2013)) oraz na udział krów wybrakowanych z poszczególnych powodów (procedura FREQ z pakietu SAS (2013)). Wykazano niekorzystny wpływ ( $P \leq 0,01$ ) zwiększania liczby krów w stadzie na długowieczność i wydajność życiową. Również dążenie do wysokiej wydajności w pierwszej laktacji ( $> 10\ 000$  kg mleka) może skrócić ( $P \leq 0,05$ ) okres życia krów. Spośród wybrakowanych krów, aż 90% usunięto ze stad z powodów przez hodowców nie zamierzonych. Niepokojący jest fakt szczególnie wysokiego (92%) jego udziału w stadach największych ( $> 100$  krów). Główną przyczyną brakowania była jałowość, przy czym stwierdzono wyraźne nasilenie brakowania z tego powodu wśród krów, które po raz pierwszy wycieliły się jako najstarsze ( $> 30$  mies. życia), ewentualnie jako pierwiastki dały ponad  $10\ 000$  kg mleka, lub były użytkowane w stadach o obsadzie 51–100 krów.

**Słowa kluczowe:** brakowanie, długowieczność, krowy mleczne

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