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THE PRODUCTIVE LIFETIME OF SOWS ON TWO FARMS FROM THE ASPECT OF REASONS FOR CULLING*

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Abstract

The aim of this study was to compare the characteristics of the productive lifetime (PLT) of sows kept on two farms, from the aspect of reasons for culling. The study was based on data from animals from two breeding farms in Hungary, using the data of 3493 crossbred Dutch Large White and Dutch Landrace sows (DLW × DL) between their first farrowing until the time of culling (2006 and 2012). For six years, the annual culling rate for both farms averaged 45%. The most frequent reasons for removal on both farms were reproductive problems (40%, 51%), leg problems (29%, 23%) and mortality (19%, 15%). There was a significant difference between the distributions of reasons for culling on the two farms (χ^2=41.7, P≤0.001). The distributions of reasons for culling differed in three periods of sow breeding (Farm A: χ^2=264.7, P≤0.001; Farm B: χ^2=511.1, P≤0.001). The percentage of main removal reasons decreased, whereas the frequency of culling due to age increased. Using survival analysis (Kaplan-Meier method and Cox proportional hazard model), significant differences were identified between the PLT of sows culled due to reproductive problems (P≤0.001), leg problems (P≤0.001) and old age (P≤0.001). Reproductive problems (HR: 1.34, P≤0.001) and leg problems (HR: 1.39, P≤0.001) were higher and culling due to old age (HR: 0.44, P≤0.001) was lower on Farm A compared to Farm B. There were no significant differences between the two farms in terms of mortality (HR: 0.99, P=0.923). Overall, the results can be useful for breeders of crossbred (DLW × DL) sow populations in more accurately defining their culling systems.

Key words: reasons for culling, flooring system, productive lifetime, survival analysis

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Clear consensus has not been reached in the scientific literature regarding the definition of longevity (Hoge and Bates, 2011). Some definitions are based more on production efficiency (lifetime piglets born alive per parity, annualized lifetime pigs weaned), while others are more time-dependent (parity at removal, length of productive life (PLT); Sobczyńska et al., 2014).

Sow PLT has a significant effect on swine farm profitability. A reduced lifetime for the sow represents both an economic loss for the producers, as well as an animal welfare problem (Aasmundstad et al., 2014). An improvement in PLT substantially decreases replacement costs and enables the achievement of increased performance in the herd by having more mature sows (Hoge and Bates, 2011).

Older sows have usually been exposed to the diseases present on a farm and, therefore, offer the benefits of being able to provide more immunity to their offspring (Sobczyńska et al., 2013). However, the acceleration of the reproductive cycle of sows due to genetic improvement increased their replacement rate (Stalder et al., 2004). Approximately 50% of sows in piglet production are culled every year (Boyle et al., 1998; Engblom et al., 2007) and sows are often removed from the breeding herd before reaching their break even parity (Nikkilä et al., 2013). A proper culling policy in sow herds is a prerequisite to maintain a stable parity profile for breeding animals (de Jong et al., 2014).

In scientific literature, several factors that influence the lifetime of sows and, therefore, the culling rate, have been discussed. Not only the genetics of these animals receive consideration, but so do also the equally important elements of nutrition, environment and management policies (Sasaki and Koketsu, 2010). In addition, it is the subjective decision of a herdsman which determines whether a sow will be removed or not. In making this decision, the herdsman considers the sow's parity number, production, reproductive status, health status and herd structure (Engblom et al., 2008 a). Moreover, culling reasons may vary over time, among countries, herds and parities (de Jong et al., 2014).

Early removal of sows from the herd due to mortality, health problems, and low productivity can involve animal welfare and economic concerns (Rodriguez-Zas et al., 2003), but the risk of removal for a breeding female is not the same throughout its life (Anil et al., 2008). Reproductive performance is the major factor influencing the voluntary culling of breeding females, since it is essential for the sow to remain productive in order to remain in the herd. A sow may be removed from the herd for production or health-related reasons. Reproductive inefficiency can directly result in poor sow longevity, whereas health problems can affect longevity both directly and indirectly (Anil et al., 2008).

Moreover, sow longevity has been shown to be genetically associated with prolificacy and leg conformation traits (Serenius and Stalder, 2006). Sows with inadequate leg conformation had greater risk of being culled than sows with an optimal leg conformation (Tarres et al., 2006 a). Leg problems of sows are also a major health problem in intensive swine production systems (Cador et al., 2014). Locomotor disorders are the second greatest reason for the (early) culling of sows, resulting in a lower average longevity of sows in a pig herd (Pluym et al., 2011).

A better knowledge of the reasons for culling can be beneficial in identifying underlying diseases or management problems, in order to increase the PLT. Poor longevity and culling for leg problems in early parities place a major financial burden on pig producers and threaten sustainability (Calderón Díaz et al., 2013).

The objective of this study was to compare, from the aspect of reasons for culling, the characteristics of PLT of crossbred Dutch Large White and Dutch Landrace (DLW * DL) sows kept on two farms.

Material and methods

Animals and housing system

Data in this study were obtained from two breeding farms (Farm "A" n = 600 sows and Farm "B" n = 700 sows) owned by a commercial swine integration company in Hungary. Records of 3493 crossbred sows (DLW × DL) culled between 2006 and 2012 were available. The sows were artificially inseminated with Large White, Pietrain and Duroc semen. The sows were kept in single crates until 30 days of pregnancy. From 30 to 110 days of pregnancy, the sows were kept in groups, housed (30±1.2) in pens measuring 45 m^2 that had nipple drinkers, electronic feeding stations and solid floors, with sparse straw in the case of Farm A, and partially slatted floors in the case of Farm B. On Farm A, fresh straw was supplied to the pen every morning, immediately after feeding. After the 110th day of pregnancy, the sows were moved to the farrowing accommodation, where they were housed in single farrowing pens. After weaning, the sows were moved to the breeding barn, where they were kept in groups of 30 in pens. Piglets were weaned at about 4 weeks of age. Animals were fed according to the Hungarian Swine Nutrition Requirements (2003). Liquid feed was provided on both farms. During the initial and the mid-period of gestation, the sows were fed 2.3 kg feed per day and 2.8 kg feed per day following the 85 day of pregnancy. Water was freely available at all times. The farms were controlled by a common management of the integration company and the veterinarian was the same, but the staff and the inseminators were different. Although the reasons for culling on the two farms were the same, the classification of sows according to the reason why they were culled was made by different people.

Sample collection

The data set contained individual performance data (e.g. date of first farrowing, number of piglets born alive per parity) and information about the removal (date of culling, reasons for culling). On the basis of a decision made by farm management, the sows were typically culled after the 8th parity. For both farms, the annual culling rate averaged 45% for six years. PLT of sow was calculated as the difference in days between the date of culling and the date at first parity (Tarrés et al., 2006 a). In the examined period, there were 638 gilts (18% of total animals) culled without any farrowing; therefore, these animals were not included in the analysis. Culling criteria were the same on both farms. Reasons for culling were categorized in five main groups, in order to perform the comparative examination (Table 1). “Reproductive problems” included all problems connected to fertility and productivity, such as anoestrus of sows, return to oestrus, negative pregnancy diagnosis, abortion, low number of pigs born alive, and low number of weaned pigs. “Leg problems” included lameness, foot and claw lesions, and joint locomotor problems. “Old age” included the sows that farrowed 8 times. “Mortality” denotes culling when the sow was found dead (post-mortem report not recorded) or sows were euthanized. “Others” included no recorded reasons and reasons of low frequency (<5%), such as thin sow syndrome, cardiovascular, respiratory and gastrointestinal diseases. Based on the litter size per parity and the study of Tarrés et al. (2006 b), the productive life of sows was divided into 3 periods (Table 2). The first period was the initial stage, when the young sows produced fewer piglets (Knecht and Duziński, 2014), including the 1st and 2nd parities (Period I). The next period (between the 3rd and 6th parities) is the production peak, when the number of pigs is the highest (Period II). Finally, the last period (7th and 8th parities) is the end of production (Period III). In Period III, parities are characterized by smaller litter sizes and health status is also lower (Tummaruk et al., 2000).

Statistical analysis

The frequencies of reasons for removal in the total lifetime and separated into the periods of PLT were calculated for the two farms and the significance of differences was tested using the Pearson’s chi-square test and Pearson residuals were calculated. Pearson chi-square tests were used to test the alternative hypothesis that an association existed between culling reasons and farm type. Pearson residuals in the case of independence refer to significantly higher (+) or lower (–) frequencies than theoretical frequencies. We used the Kaplan-Meier (KM) method, a model which can be used to estimate the survival rate (SR) at each point of time when the event (removal) occurs, in order to indicate the differences between the farms survival probability curves. The significance of differences was tested using the log rank (LR) test at the level of 5%. Hazard ratios for each removal reason were computed using the Cox proportional hazards (PH) model (Maia et al., 2014). This risk analysis model can estimate the effect of treatment (Farm type) as a function of a time-dependent variable (PLT). The value of point estimate gives the hazard ratio (HR) for the effect of the treatment. Farm A, with solid flooring, was considered to be the reference category, because there is a reference in the technical literature to a more positive physiological effect of solid flooring, as compared to slatted flooring (Cador et al., 2014).

Pearson residuals were calculated using the R program (Meyer et al., 2006; Nenadic and Greenacre, 2007; R Core Team, 2014) and all other statistical analyses were carried out using SPSS 22.0 computer software.

Results

The most frequent reasons for removal were reproductive problems, leg problems and mortality (about 90% of all removal) on both farms (Table 1).

Table 1. Frequency (number and percentage) of the different culling reasons on both farms

	Farm A	Farm B	Total
Reproductive problems	445 (40%) –	884 (51%) +	1329 (47%)
Leg problems	326 (29%) +	393 (23%) –	719 (25%)
Mortality	209 (19%) +	254 (15%)	463 (16%)
Old age	93 (8%)	109 (6%)	202 (7%)
Others	49 (4%)	93 (5%)	142 (5%)
Total of sows	1122	1733	2855

Pearson's chi-square test χ^2=41.679, P≤0.001.
sign '–' indicates value of Pearson residuals ≤-2.0; sign '+' indicates value of Pearson residuals ≥2.0, P≤0.001.

Based on the Pearson residuals, it can be observed that, on Farm A, the frequency of reproductive problems was significantly lower than the theoretical frequency while the frequency of leg problems and mortality was higher. Furthermore, the frequency of reproductive problems on Farm B was higher and the frequency of leg problems was significantly lower than the theoretical frequency.

The percentages of different causes of culling throughout the sow's productive life are shown in Table 2. Twenty-five percent and 36% of sows on Farm A and B, respectively, were removed in the first period, when most sows were culled due to reproductive problems, followed by leg problems and mortality. The order of importance of reasons for culling was the same on both farms, but the ratio of removal due to the same reason was different.

On both farms, the mean of culling per parity by period was not higher than 200, except for the first period of Farm B, where the mean of culling per parity was 316.

Table 2. Number and percentage of the different causes of culling throughout the sow's productive lifetime (PLT) and the mean of culling per parity by periods

		Period I[a]	Period II[b]	Period III[c]
Farm A	Reproductive problems	124 (44%)	216 (41%)	105 (34%)
	Leg problems	80 (28%)	167 (31%)	79 (26%)
	Mortality	76 (27%)	107 (20%)	26 (9 %)
	Old age	0 (0%)	5 (1%)	88 (29%)
	Others	4 (1%)	38 (7%)	7 (2%)
	Total[d]	284 (25%)	533 (48%)	305 (27%)
	Mean of culling/parity	142	133	153
Farm B	Reproductive problems	384 (55%)	422 (55%)	114 (35%)
	Leg problems	152 (24%)	193 (25%)	48 (15%)
	Mortality	107 (17%)	111 (14%)	36 (10%)
	Old age	0 (0%)	1 (0.1%)	108 (33%)
	Others	24 (4%)	45 (6%)	24 (7%)
	Total[d]	631 (36%)	772 (45%)	330 (19%)
	Mean of culling/parity	316	193	165

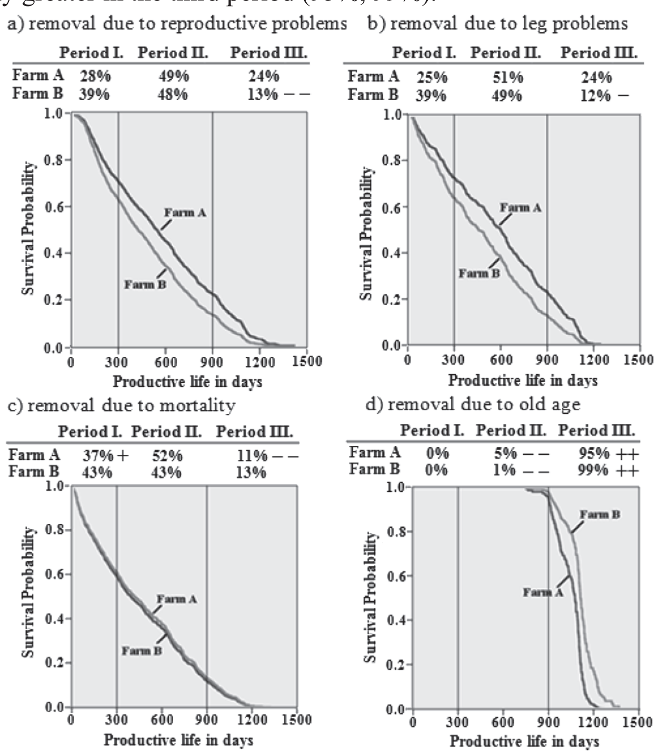
a – 1st and 2nd parity; Pearson's chi-square test χ^2=24.714, P≤0.001 (without old age category).
b – between 3rd and 6th parity; Pearson's chi-square test χ^2=28.921, P≤0.001.
c – 7th and 8th parity; Pearson's chi-square test χ^2=19.690, P=0.001.
d – Frequencies within the same row add up to 100%.

The distributions of reasons for culling differed in the three periods of sow production (Farm A: Pearson's chi-square test χ^2=264.712, P≤0.001; Farm B: Pearson's chi-square test χ^2=511.125, P≤0.001). It was observed at the end of the production period that the percentage of main removal reasons decreased and the frequency of culling due to age increased.

As the relative importance of the various causes of culling was different throughout a sow's PLT, the occurring of each reason of removal was also expected to be different throughout her productive life.

When examining each period separately, there was also a significant difference between farms in terms of the distribution of reasons for culling (Period I: χ^2=24.714, P≤0.001; Period II: χ^2=28.921, P≤0.001; Period III days: χ^2=19.690, P=0.001).

Examining the farms separately, on Farm B, the Pearson residuals (Figure 1, table parts) were significantly lower than the theoretical frequency in the case of reproductive problems (13%) and leg problems (12%) in the last period. On Farm A, the frequency of mortality was significantly greater than theoretical frequency in the first period (37%), while it was lower in the third period (11%). The frequency of old age was significantly lower in the second period (5%, 1%) in both cases, and it was significantly greater in the third period (95%, 99%).



sign '–' indicates value of Pearson residuals ≤-2.0; sign '– –' indicates value of Pearson residuals ≤-4.0; sign '+' indicates value of Pearson residuals ≥2.0; sign '+ +' indicates value of Pearson residuals ≥4.0; P≤0.001.

Figure 1. Kaplan-Meier survival functions and percentages of different causes of culling (reproductive problems, leg problems, mortality, old age) throughout a sow's productive life by period

The survival curves give a visual representation of the differences between the farms from the aspect of reasons for culling and the percentages of failures regarding the different causes of culling throughout a sow's productive life (Figure 1).

In the case of reproductive problems (Figure 1 a), sows kept on Farm A showed higher survival probability. The median of lifetime of sows was 620 ± 21.7 days on Farm A and 400 ± 16.7 days on Farm B. The result of the LR test showed a significant difference at the level of $P \leq 0.001$.

In the case of leg problems (Figure 1 b), the sows kept on Farm A had also higher survival probability. The median PLT of sows was 610 ± 24.4 days on Farm A and 423 ± 31.4 days on Farm B. The result of the LR test showed a significant difference at the level of $P \leq 0.001$.

Contrary to these findings (Figure 1 c), there was no significant difference for mortality between farms. The median of lifetime was 428 ± 30.6 days on Farm A and 394 ± 36.5 days on Farm B.

In the case of old age (Figure 1 d), the results differed from the previous values. The sows kept on Farm A have lower survival probability. The median PLT was 1037 ± 22.8 days on Farm A and 1116 ± 6.0 days on Farm B. The result of LR test showed a significant difference at the level of $P \leq 0.001$.

The effect of farm on the risk of culling was highly significant ($P \leq 0.001$) in the case of culling due to reproductive problems, leg problems and old age (Table 3).

Table 3. Number of sows culled, regression coefficient, standard error of the coefficient, hazard ratio and 95% confidence interval with different culling reasons in the case of the Cox PH model

Culling reasons	N	B	SE	HR[1]	CI (95%)	χ^2 P-value
Reproductive problems	1329	0.29	0.06	1.34	(1.19–1.50)	<0.001
Leg problems	719	0.33	0.08	1.39	(1.20–1.62)	<0.001
Mortality	463	–0.01	0.09	0.99	(0.82–1.19)	0.923
Old age	202	–0.82	0.15	0.44	(0.33–0.59)	<0.001

N – number of animals; B – regression coefficient; SE – standard error of B; HR – hazard ratio; CI – confidence interval of HR.

[1]the reference category was Farm A.

The risk of culling due to reproductive problems was 1.34 times higher for sows kept in Farm B compared to sows in Farm A. The risk of culling due to leg problems was 1.39 times higher in Farm B than in Farm A. For mortality, no significant difference was detected between the farms. However, the value of risk of culling due to old age was below 1, indicating that the risk of culling is lower for sows kept on Farm A than for sows kept on Farm B.

Discussion

There is a limitation that should be noted when interpreting the results in this study. This study was not a controlled experiment, but an observational study performed using data from only two breeding herds. However, even with such limitations, this research provides valuable information about the quantitative relationship among culling reasons and sow PLT for pig producers and veterinarians.

Reproductive failure as the main reason for culling is consistent with other studies (Engblom et al., 2007; Segura-Correa et al., 2011); however, the frequency of culling due to reproductive reasons in the present study (Farm A 40%, Farm B 51%) was much higher than reported in most studies; 26.9% (Segura-Correa et al., 2011), 27% (Engblom et al., 2007, 2008 b), 50% (de Jong et al., 2014) and 70.8% (Masaka et al., 2014).

Similarly de Jong et al. (2014) found that the most common reason for culling was insufficient reproductive performance, with no pregnancy (18%), few piglets weaned (14%) and no oestrus (10%). These percentages are in line with Roongsitthichai et al. (2010). The comparison of results between different studies is however not always straightforward, as not all studies used the same subdivisions of reasons for culling. In fact, in all studies, including this one, the percentage of sows culled for insufficient reproductive performance is likely to be higher, as many old sows culled due to "old age" also show decreased reproductive performance (de Jong et al., 2014).

The percentage of culling due to reproductive reasons in early parities (0– 2) was lower on Farm A and slightly higher on Farm B, compared to Masaka et al. (2014) study (52.2%), even though both farms have lower proportions than reported by Dhliwayo (2007) for the same parities.

Examining the survival functions (Figure 1) it can be stated that in the case of every reason for culling (except for old age), the survival probability abruptly started to decrease already in the first period, as reported by Fernandez de Sevilla (2008) for Large White, Landrace and Duroc breeds. In line with our results Yazdi et al. (2000) also reported an increase in the risk of culling after weaning for the first 3 litters.

Similarly to our results, in the Fernandez de Sevilla et al. (2009) research study based on Duroc sows, the survival curve for the low productivity data set started to decline 127 days after the first fertile mating. The descent followed a cyclic pattern with reductions in every 130 to 160 days.

In our estimation, the percentages of leg problems were 23–29% within the wide range among farms (0–39%) found by Seddon and Brown (2014) and Sobczyńska et al. (2014). The reason for the differences between the farms could be the fact that the true prevalence of lameness is higher, as it often remains undetected until the sow's condition deteriorates. The reason of culling due to leg problems might be similar to Knauer et al. (2007), where culling reasons are typically based on external signs or indications and do not incorporate evidence of internal lesions or results from diagnostic testing.

The incidence of the culling due to leg problems was quite high at the initial period (28% and 24%) and during the highest production stage, especially on Farm A (31%). The frequency of culling due to lameness was high for the lower parities (0–2) in agreement with another study (Engblom et al., 2007). The proportion of removal due to lameness in sows at the end of productive life was lower similarly to Segura-Correa et al. (2011) and Pluym et al. (2011), but differed from Masaka et al. (2014), who reported high frequency in parities ≥9. Younger sows were at a higher risk compared to older sows (parity 3 or higher), similarly to Heinonen et al. (2006). This trend of decreasing risk with ageing might be the result of a strict culling strategy.

Engblom et al. (2008 a) also found that the hazard for removal is greater for first parity sows than for other age groups. The reason for these results was that the pig producers removed young sows with affected legs and, therefore, sows with good legs remained in the subsequent parity groups. Based on our results, it can be concluded that the management policy on Farm A was similar to that discussed above. D'Allaire et al. (1987) also found that if the culling reason was lameness, sows were removed at a younger age compared to the case if the culling reason was something else. Yet another reason could be that the high prevalence of different leg problems (such as claw lesions) might be linked with the intensive farming of pigs on concrete floors with minimal or no bedding, as reported by Cameron (2012).

Based on the data of descriptive statistics, it can be said that a higher proportion of culling due to leg problems was observed on Farm A. However, the survival analysis showed that the sows on Farm A were removed due to leg problems significantly later than sows on Farm B.

Sows with inadequate leg conformation had 1.4 times greater risk of being culled than sows with an optimal leg conformation, similar to Tarres et al. (2006 a), but lower than found by Anil et al. (2009) (HR=1.71). On Farm A, it could be observed that sows with leg problems were removed as soon as any leg failure was perceived (this is the cause of the high culling rate due to leg problems). In the case of Farm B, a lower percentage of sows was culled due to leg problems, despite the slatted flooring system. Similarly in Andersen and Bøe (1999), all results also indicate that herds with concrete floors had fewer leg problems.

Removal attributed to sow mortality (Table 1) was higher than in Engblom et al. (2008 b) (4%) and Karg and Bilkei (2002) but similar to Mondal et al. (2012), with Masaka et al. (2014) noting annual mortality rates from 12.18 to 15.6.

In our study, the frequency of culling due to old age was 6–8%, compared to other studies (14–31%, D'Allaire et al., 1987; Boyle et al., 1998; de Jong et al., 2014). The reason for this was that most sows were removed before their 8th parities. However, Tummaruk et al. (2000) noted that the highest number of piglets born for parity is 4–6. Yet, according to Huirne et al. (1991), the optimal replacement policy is based on the longest economic life of average producing sows, and they report sows having nine parities.

The present study documented that sows are mostly (40–51%) culled because of insufficient reproductive performance. In our analysis, significant differences in the survivability of culled sows with different culling reasons in two breeding herds were found. Reproductive problems and leg problems were higher (HR: 1.34 and 1.39) and old age culling was lower (HR: 0.44) on Farm B, compared to Farm A. There were no significant differences between the two farms in the reason for culling when this was mortality (HR: 0.99). It can be concluded that not only technology, but also culling policy, has a significant effect on the production of breeding farms. Overall, the results can be useful for breeders of crossbred (DLW × DL) sow populations, in more accurately defining their culling systems.

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