Evaluation of patterns of removal and associations among culling because of lameness and sow productivity traits in swine breeding herds

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Objective—To characterize patterns of removal and evaluate the associations among culling because of lameness and sow productivity traits among culled gilts and sows.

Design—Cross-sectional study.

Sample Population—Data from a convenience sample of 11 farms pertaining to the removal of 51,795 gilts and sows from January 1991 to December 2002. Mean culling and mortality (death and euthanasia) rates for all inventoried gilts and sows ranged from 23% to 50% and 4.7% to 9.5%, respectively.

Procedure—An analysis of categories of removal (cull, death, or euthanasia) and reasons for removal of gilts and sows was performed. Multivariate logistic regression was used to determine associations among culling because of lameness and sow productivity traits among culled gilts and sows.

Results—Among sows that were removed, the proportion of parity ≥ 1 sows that died (both death and euthanasia) was >3 times the proportion of parity ≥ 1 sows that were culled within 20 days after farrowing. Among lame sows that were removed, the proportion of parity ≥ 1 sows that died (death and euthanasia) was higher than the proportion of parity ≥ 1 sows that were culled within 20 days after farrowing. Among sows that were removed, the proportion of sows that died (death and euthanasia) in the category of others was higher than the proportion of parity ≥ 1 sows that were removed within 20 days after farrowing. Among sows that were removed, the proportion of sows that died (death and euthanasia) in the category of others, whereas the category of diseases included injuries other than lameness, lameness, reproductive reasons, others, and a category in which no reason was included. The removal categories included in the study depended on the entries in the database. The removal categories included in the study depended on the entries in the database.

Conclusions and Clinical Relevance—The proportion of death among removed sows, especially lame sows, was higher during lactation than nonlactation. Results indicated that risk of death is not the same for sows throughout their lifetime. (J Am Vet Med Assoc 2005;226:956–961)

Materials and Methods

Data from a convenience sample of 11 farms in Canada pertaining to the removal of 51,793 sows from January 1991 through December 2002 were retrieved from a datashare database. The removal categories included in the study depended on the entries in the database and included culled, death, euthanasia, transfer (to another facility), and a category in which the type of removal was not mentioned. The reasons for removal also depended on the entries in the database and were broadly categorized into the following: diseases, injuries other than lameness, lameness, reproductive reasons, others, and a category in which no reason was included. The results reported such as electrocution, genetics, heat stress, other, stress syndrome, and suffocation were included in the category of others, whereas the category of diseases included reasons such as mastitis, metritis, meningitis, and similar illnesses. Injuries other than lameness included conditions such as abscess, accident, cuts or lacerations, injury, and udder trauma.

Lameness in swine results in decreased animal well-being and economic loss to the producer. Lameness is considered to be an effective animal-based indicator of well-being in pigs. The economic impact of lameness in swine may be attributable to the fact that lame animals will not attain optimal breeding efficiency and may be culled before they attain their peak production. Locomotor problems are reported to be a major reason for culling in swine herds. In Canada, 10% to 14% of removed sows are reportedly attributable to locomotor problems. Annual removal and culling rates reported in those studies were 44.2% and 30% to 34%, respectively. Sows culled because of lameness are removed at a younger age than those removed for other reasons. Early removal of sows before they attain maximum litter size may result in low herd mean litter sizes, number of litters per sow per year, and number of pigs weaned per sow per year, thus increasing the cost per weaned pig. Therefore, reducing the number of sows culled for lameness may increase the proportion of sows of higher parity in the herd and would bring in the associated advantages in terms of litter size and farrowing rate. There are different causal factors for lameness, the most common being the flooring of the housing system. Leg weakness and lameness may have a genetic link; however, the housing system, type of floor, and bedding are predictors of the prevalence and severity of the problem. Low feed intake and consequent reduction in body condition may also lead to lameness. Nutritional deficiency is reportedly one of the main causes of lameness in sows. Nutritional elements such as biotin have beneficial effects on maintaining claw integrity. Lack of exercise may contribute to lameness. Selection of gilts for leg conformation is also important in avoiding development of leg problems.

Although many causes of lameness are known, elimination of all causes of lameness is not always practical because of economic reasons. A better understanding of the pattern of removal because of lameness among sows and the effect on productivity would help to formulate strategies to minimize removals because of lameness. The purposes of the study reported here were to characterize patterns of removal (cull, death, and euthanasia) in swine breeding herds and evaluate the associations among culling because of lameness and sow productivity traits among culled gilts and sows.

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The criterion for selection was that farms have a record of the reasons for ≥85% of removed sows. Farms were chosen to represent large-scale intensive production in western Canada. The 11 farms had data for 5 to 11 years, depending on the establishment of the herd.

Analysis of the database performance monitor reports indicated that the mean culling and mortality (death and euthanasia) rates for all inventoried females across these farms from January 1991 to December 2002 ranged from 23% to 50% and 4.7% to 9.5%, respectively. The mean female inventory across these farms for the period was 917. Genotypes of gilts and sows were from commercially available female lines. Gilts and sows were housed in pens or stalls on partial or fully slatted floors. A sow's lifetime productivity indicates the economic performance of a sow during its stay in the herd and are important reference points when making culling decisions, especially when culling for productive or reproductive reasons. Therefore, the performance of the sow was categorized into 3 parity classes: parity 0 (P0), parity 1 (P1), and parity >2 (P2). Within the parity class, the number of pigs born alive per parity (life mean born alive; mean ± SE, 10.11 ± 0.011) were analyzed for associations with culling because of lameness among the culled sows. The performance of the sow in the parity range may be a function of the severity of lameness. Hence, the total number of pigs born alive in the removal parity (mean ± SE, 9.59 ± 0.016), the number of pigs weaned in the parity before culling (mean ± SE, 8.74 ± 0.014), and previous farrow to first service interval (median, 25; range, 0 to 262) were also included in the analysis. In the database, reasons for removal of sows are recorded by herd personnel and are not necessarily based on diagnosis as determined by a veterinarian or necropsy findings. Therefore, to account for possible variations in recording of data, lameness included all those conditions generally used to represent locomotor problems in gilts and sows, including lameness, nonambulatory sows, joint infection, and musculoskeletal problems.

Statistical analyses—All analyses were performed with statistical software. The outcome evaluated was culling because of lameness, compared with other reasons for removal among the gilts and sows culled. Because of differences in reproductive performance and variables and the possible variation in reasons for removal among gilts, sows of parity 1, and sows of parity >1, the records were grouped on the basis of the parity in which gilts and sows were removed (removal parity) into 3 categories: parity 0 (P0), parity 1 (P1), and parity >2 (P2). Within the removal parity category, the frequencies of removal categories and reasons for removal were reported. The proportions of major removal categories (cull, death, and euthanasia) among parity classes, nonlactating and lactating sows, and nonlactating and lactating lame sows that were removed were compared by use of a 2-sample test for equality of proportions. The cumulative proportions of cull, death, and euthanasia among the removed gilts and sows and among those removed for lameness were analyzed for 120 days after farrowing. Separate logistic regression models were fitted for the 3 parity categories among the gilts and sows that were culled with culling because of lameness as the dichotomized outcome variable. The year of removal and farm were included as random effects in the logistic regression models to consider the possible variation in management policies and stockmanship on gilt and sow removals and the recording of removals within and between farms and market changes during the study period. Farm was included as a random effect to account for the between-farm variation in management. Other categories of removal (death, euthanasia, not mentioned, and transfer) were not included in the regression analysis. In the regression models, the removal parity of P ≥2 sows was further separated into 2 categories (parity 2 to 5 and parity >5) to consider the difference in the explanatory variables in younger and older sows. Poor reproductive performance was a major reason for culling sows in breeding herds, and reproductive problems are usually aggravated in summer months. Increased culling for reproductive problems in summer may affect the rates of culling caused by other reasons, depending on factors such as the availability of replacement females. Therefore, season was also included as a variable in the analysis. For this, the months in which gilts and sows were removed were grouped into 2 seasons: summer (June, July, August, and September) and nonsummer (all other months). Previous farrow to first service interval was categorized into 2 groups (greater than or equal to the median and less than the median). The median value of 25 days was used to categorize previous farrow to first service interval on the basis that a sow with a lactation length of 21 days will be bred by 25 days after farrowing. The number of pigs born alive in the removal parity and number of pigs weaned in the parity before culling, life mean born alive, LLFY, and life mean NPD were included in the models as continuous variables. Dummy variables were constructed for all categorical variables.

Season was the only explanatory variable included in the models for P0 females. For P1 sows, the explanatory variables were life mean NPD, season, and life mean born alive. For P ≥2 sows, LLFY, life mean born alive, removal parity, number of pigs weaned in the parity before culling, and previous farrow to first service interval were also included as explanatory variables, in addition to the variables included in the model for P1 sows. All variables were included and retained in the respective models regardless of their level of significance. Values of P ≤0.05, as determined by the Wald test, were considered significant in all analyses.

Results Culling was the major pattern of removal in all parities of removed gilts and sows (Table 1). The proportions of cull, death, and euthanasia between P0 and P1, P0 and P ≥2, and P1 and P ≥2 females were significantly (P <0.001 for all) different. The proportion of culling was higher in P0 females than in P1 and P ≥2 sows. However, the proportions of death and euthanasia were lower in P0 females. The proportions of cull, death, and euthanasia among nonlactating and lactating sows that were removed were also significantly (P <0.001 for all) different. Among removed sows, a significantly (P <0.001) higher proportion of P1 sows were removed for lameness, compared with P0 and P ≥2 sows. The proportions of cull, death, and euthanasia of sows removed because of lameness was significantly (P <0.001 for all) different between nonlactating and lactating sows (Table 2). A small proportion of P0 females were removed, and no additional information on the category of removal was recorded. Of the total number of gilts and sows removed in these herds, no reason was reported for 10.06%. Reproductive reasons contributed to >50% of the total number of gilts and P1 sows removed. With the exception of reproductive reasons, the number of gilts and sows removed for lameness was higher than that removed for other reasons. Of the total number of P1 and P ≥2 sows removed within 20 days of farrowing, 49% and 45% of sows died or were euthanatized, respectively, whereas only 14%
Of sows were culled (Figure 1). Among lame P1 sows that were removed, 20% of sows had died within 10 days after farrowing and the proportion of sows that died increased to 38% in the next 10 days (Figure 2). By 20 days after farrowing, 40% of lame P1 sows had been euthanatized, whereas only 24% of lame P1 sows had been culled. The proportions of culling and euthanasia followed a similar pattern among lame P1 sows that were removed.

Among lame P ≥ 2 sows that were removed within 20 days after farrowing, 40% of lame P1 sows had been euthanatized, whereas only 24% of lame P1 sows had been culled. The proportions of culling and euthanasia followed a similar pattern among lame P1 sows that were removed.

Among lame P ≥ 2 sows that were removed within 20 days after farrowing, 45% and 41% of sows died or were euthanatized, whereas only 23% of lame P ≥ 2 sows were culled (Figure 3). The proportion of lame P ≥ 2 sows that died 10 days after farrowing was 30%. The proportions of P1 and P ≥ 2 sows that were culled because of lameness were similar.

The odds of gilts and sows being culled because of lameness were significantly ($P < 0.05$) higher during non-summer months than summer months (Table 3). Sows of parity ≥ 2 that were culled because of lameness were at significantly higher odds of being culled as of nonlactating sows of parity 1 (P1) and parity ≥ 2 (P ≥ 2) at 11 swine production farms in Canada from January 1991 through December 2002.

### Table 1—Removal categories and reasons for removal of females of parity 0 (P0) and lactating and nonlactating sows of parity 1 (P1) and parity ≥ 2 (P ≥ 2) at 11 swine production farms in Canada from January 1991 through December 2002.

<table>
<thead>
<tr>
<th>Categories</th>
<th>P0 %</th>
<th>P1 %</th>
<th>P ≥ 2 %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cull</td>
<td>9.38</td>
<td>87.17</td>
<td>7.00</td>
<td>81.07</td>
</tr>
<tr>
<td>Death</td>
<td>600</td>
<td>6.32</td>
<td>629</td>
<td>9.6</td>
</tr>
<tr>
<td>Euthanasia</td>
<td>459</td>
<td>4.26</td>
<td>763</td>
<td>8.84</td>
</tr>
<tr>
<td>Not mentioned</td>
<td>182</td>
<td>1.69</td>
<td>23</td>
<td>0.27</td>
</tr>
<tr>
<td>Total</td>
<td>10,763</td>
<td>8,835</td>
<td>3,237</td>
<td>51,795</td>
</tr>
</tbody>
</table>

Proportions of cull, death, and euthanasia were significantly ($P < 0.001$) different between parity categories, and proportions of cull, death, and euthanasia were significantly different ($P < 0.001$) between nonlactating and lactating sows.

### Table 2—Major removal categories for nonlactating and lactating sows removed because of lameness at 11 swine production farms in Canada from January 1991 through December 2002.

<table>
<thead>
<tr>
<th>Category</th>
<th>Nonlactating removed (n = 24,733)</th>
<th>Lactating removed (16,299)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>Cull</td>
<td>1,371</td>
<td>5.54</td>
</tr>
<tr>
<td>Death</td>
<td>106</td>
<td>0.43</td>
</tr>
<tr>
<td>Euthanasia</td>
<td>836</td>
<td>3.38</td>
</tr>
</tbody>
</table>

Proportions of cull, death, and euthanasia were significantly different ($P ≤ 0.001$) between nonlactating and lactating sows.
LLFY increased. Similarly, P1 and P ≥ 2 sows that were culled because of lameness were at significantly higher odds of being culled as the total number of pigs born alive in the removal parity increased. Among culled P1 sows, the odds of culling because of lameness decreased significantly as life mean NPD increased. Among culled P ≥ 2 sows, the odds of culling because of lameness increased significantly as life mean born alive increased. The number of pigs weaned in the parity before culling and previous farrow to first service interval were not significantly associated with the likelihood of culling because of lameness among sows that were culled. Of the P ≥ 2 sows that were culled, sows of parity 2 to 5 had significantly higher odds of being culled for lameness than sows of parity > 5.

**Discussion**

The categories for removal and number of removed sows are important for economic sustainability and welfare of the herd. The adverse effects of decreased sow longevity on sow welfare and economic sustainability are maximized when lame sows are left within the herd to die because lameness is known to be painful and because of the reportedly higher risk of removal due to locomotor problems in first parity sows. Results of other studies indicate that the likelihood of a female being culled for lameness is greater for gilts and first parity sows among the removed females. These gilts and first parity sows are removed from the herd before they attain their expected life in the herd and thus adversely affect the economic performance of the herd.

In our study, the high proportion of deaths of sows during lactation, compared with the nonlactation period, is in agreement with results of previous studies. The proportion of deaths was also higher in lame sows during lactation, compared with the nonlactation period. Lactation is the most stressful period in the life of a sow, and the highest proportion of deaths would be expected during this period even when the overall mortality rate is low. Causes of death among sows in this study were not always determined by a veterinarian or necropsy findings.

The proportion of sows that were culled during lactation was lower than that in the nonlactation period, which may partly explain the high proportion of deaths observed during lactation in comparison to the nonlactating period. Approximately 50% of removed sows were culled within 40 days after farrowing. The interval between a production event and removal is of economic importance in a breeding herd because it affects the number of nonproductive days and is a biological predictor of the litters per sow per year. Timely and adequate culling of sows at risk may decrease the proportions of death and euthanasia. However, unlike death, culling is a voluntary decision and producers may not want to cull sows before weaning if possible because of the management and economic implications of sow removal at this stage and the welfare of piglets. In our study, the high proportion of culling after weaning may have indicated that producers chose to retain sows throughout lactation.

The referent group in the regression analysis was composed of gilts and sows culled mainly for repro-

![Figure 3](image_url)
ductive reasons, and except for season, farm, and year, reproductive reasons were the predominant explanatory variable included in the logistic regression models. Therefore, it may be possible that gilts and sows that were not culled for lameness are the ones culled for reproductive reasons. However, it may be assumed that there is a biological association between diseases such as lameness and productivity; thus, the variables that were selected were expected to explain the outcome that was evaluated. The higher odds of culling for lameness during nonsummer months among culled females was likely because the incidence of reproductive problems is more severe in summer months than nonsummer months; thus, gilts and sows were culled for that reason. The lower odds of culling because of lameness in summer months in culled P ≥ 2 sows, compared with culled P0 and P1 females, may be due to the higher incidence of reproductive problems in younger females, which becomes more severe in summer months; therefore, younger females may be culled for poor reproductive performance rather than for lameness. Our data also indicated an increase in the proportion of reproductive problems in summer months among sows that were removed. The percentages of P0, P1, and P ≥ 2 females removed in summer months for reproductive problems were 73.68%, 76.84%, and 43.23%, respectively, whereas the corresponding percentages in nonsummer were 72.77%, 64.59%, and 42.18%, respectively.

The likelihood of culling because of lameness increased in P ≥ 2 sows as LLFY increased; sows with higher LLFY were productive, less likely to be culled because of productive or reproductive reasons, and therefore were more likely to be culled because of lameness. Similarly, among P1 and P ≥ 2 sows, the odds of culling because of lameness increased significantly as the total number of piglets born alive in the removal parity increased because those sows were less likely to be culled because of reproductive reasons. As life mean NPD increased, the likelihood of culling because of lameness in P1 sows decreased because such sows were less productive and more likely to be culled because of reproductive reasons than because of lameness.

The odds of culling because of lameness among P ≥ 2 sows increased significantly as life mean born alive increased. This trait represents high productivity, and sows with high values for life mean born alive were less likely to be culled because of reproductive reasons and were more likely to be culled because of lameness. Among P ≥ 2 sows, sows of parity 2 to 5 are reportedly more productive than older sows and less likely to be culled for reproductive failure than old sows; therefore, the odds of old sows being culled because of lameness was high. Of the reproductive variables associated with culling because of lameness, LLFY had a higher odds ratio than the total number of pigs born alive in the removal parity and life mean born alive, suggesting that the mean number of litters during a sow's lifetime is more important than the number of piglets born alive per litter when deciding whether to cull for poor reproductive performance.

The inclusion of farm and year as random effects had an effect on the magnitude and sign of risk factors, suggesting that both farm and year of removal are also influential in determining the likelihood for culling of sows because of lameness. This is an indication of the influence of management policies and stockmanship on the decision to remove sows and the recording of those decisions, which could not be analyzed in this study. Similarly, variation in the likelihood of culling of sows because of lameness during the study period may be a reflection of market fluctuations. However, data such as reasons for removal were recorded in the database by farm personnel and not always based on diagnosis of a condition as determined by a veterinarian or necropsy findings; therefore, variation in recording could not be excluded.

The association of reproductive variables with the likelihood of culling because of lameness suggests that a highly productive sow was more likely to have been culled because of lameness. Because culling is a voluntary decision, lame sows in an important stage of production, such as advanced gestation or lactation, may not be culled. Therefore, a bias in the recording of reasons for removal of sows may be involved. In addition, the highly productive sows are biologically more susceptible to conditions such as osteomalacia leading to lameness because they may have physical limitations in consuming the quantity of feed required to replenish the minerals secreted during heavy lactation.

A high proportion of death is an indicator of poor animal welfare, and a pregnant sow that is lame in these herds may die, as evident from the high proportion of natural deaths among lame sows within a few days after farrowing. The lower proportion of voluntary culling during lactation, compared with the nonlactation period, could be a major factor responsible for this effect. However, this reasoning does not diminish the concerns associated with death in those sows in which the cause of death is reportedly associated with conditions that do not result in sudden death.

Lameness in gilts and sows should be prevented or treated. Selection of gilts on the basis of confirmation, floor type, provision of bedding, group structure, and nutrition is important in preventing lameness. However, if treatment of lameness in gilts and sows is not an option, they should be culled or euthanatized immediately.

References


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