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Lifetime reproductive performance in female pigs having distinct reasons for removal

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Abstract

This study describes the reasons for removal of female pigs distributed across parity categories, and evaluates how parameters of lifetime productivity differ for females having distinct removal reasons. The study analyzed lifetime records from 7973 females. Those records were obtained from 28 herds from the PigCHAMP® research database having high-quality data during a five-year period. Female life expectancy corresponded to 3.3 parities at removal or 1.6 years spent in the breeding herd. The most common removal reason was culling attributed to reproductive disorders (33.6%), followed by culling for sub-optimal litter performance (20.6%). Sows culled for old age (8.7% of the removals) spent proportionally fewer days in non-productive periods, and produced more weaned pigs annually and over a lifetime than females removed for other reasons ($P < 0.05$). In contrast, females culled for reproductive failure accumulated the largest proportion of non-productive days (NPD) during the time spent in the breeding herd, and produced the fewest weaned pigs per lifetime and per year ($P < 0.05$). These findings indicate that culling for reproductive reasons is more common among low-parity females, which suggests that minimisation of NPD at early reproductive cycles is crucial to optimise female lifetime reproductive efficiency.

Keywords: Removal reason; Lifetime reproductive efficiency; Female pigs

1. Introduction

Removal rates in commercial pig herds are commonly between 40 and 55%, which usually relates to a mean parity between three and four at removal (Dagorn and Aumaitre, 1979; D'Allaire et al., 1987; Lucia et al., 1999). As a consequence, breeding herd inventories usually have high proportions of low-parity females. Thus, the majority of the female removals concentrate at low parities, being mostly attributed to reproductive failure (D'Allaire et al., 1987; Dijkhuizen et al., 1989; Patterson et al., 1996). It would be expected for such females to accumulate large amounts of non-productive days (NPD), which would relate to reproductive inefficiency due to the strong negative association between NPD accumulation and pigs weaned per female per year (PW/F/Y) (Wilson et al., 1986; Polson et al., 1990). However, the relationship between NPD and reasons for female

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removal has not been clearly characterised, since NPD are commonly estimated as a herd-level factor whereas female removal is defined as an individual event. Furthermore, associations between female removal and herd reproductive efficiency are not completely clarified. One reason for this would be because herds producing more PW/F/Y commonly produce more litters per female annually, which might result in higher culling rates due to a higher probability of removal within farrowing-to-farrowing intervals (Stein et al., 1990). Another reason would be because estimators of reproductive performance such as PW/F/Y have limited accuracy beyond a one-year scope, which justifies why parity number at removal is commonly used to approximate female life expectancy and lifetime productivity.

This study describes the distribution of removal reasons for females having different parity number at removal, and investigates how estimates of lifetime reproductive performance differ for females that were removed from the breeding herd due to distinct reasons.

2. Material and methods

2.1. Data collection and processing

Twenty-eight herds with high quality data throughout a five-year period (1986–90) were identified in the PigCHAMP® database (PigCHAMP®, 1992). The criteria used to define data quality required a maximum 10% fluctuation in breeding herd inventory. So, this study included only herds within a typical production cycle, such as those that were not under start-up, repopulation or expansion. Additionally, the qualified herds should have no more than 5% of unrecorded events for mating, farrowing or weaning during the period of interest. These criteria have been used in previous studies using retrospective database information (Polson et al., 1990; Marsh et al. 1992).

Within each herd, qualifying females were admitted to the breeding herd during the first three years, and were all removed from the herd by the last day of the fifth year (1990), having a recorded removal event. For each female the following data were collected: date of entry in the breeding herd; date of removal from the breeding herd; type of removal (cull or death); reason attributed for removal; and parity number at removal. A total of 7973 female records were gathered for further analyses. The herd that contributed the most records provided 12% of the total analysed records, followed by three herds that provided 7–8% each. On the other hand, three smaller herds provided only about 1% of the analysed records each. All herds were located in North America, distributed across Canada and the midwest region of the United States. Analysis of PigCHAMP® reports during the five-year period of interest indicated that the average annual culling rate for the herds that qualified for the study during this period was 46.9%. However, since the study was conducted at the individual female level and considered only removed females, estimates of culling rates were not calculated. Average lactation length for the qualifying herds during the period of interest was equal to 23.9 days.

The number of days spent in the herd (herd days) was estimated by the difference between the date of removal and the date of entry. The number of herd days per mated female was also estimated, after excluding the entry-to-first service interval from the total herd days, to adjust for the inconsistent recording of the entry event across herds (Polson et al., 1990; Marsh et al., 1992). For each female, the number of days spent in gestation and lactation during herd life was summed. As a NPD is any day spent by a female in the breeding herd in periods other than lactation or gestation (Wilson et al., 1986; Polson et al., 1990), the proportion of lifetime NPD was calculated by the formula below, as described by (Lucia et al., 1999):

$$\text{Lifetime NPD (\%)} = \frac{(\text{Herd days} - \text{lactation days} - \text{gestation days})}{(\text{herd days})} \times 100\%$$

The percent of lifetime NPD was also calculated on a per mated female basis.

The number of pigs produced at each parity (total, born alive and weaned) was summed to estimate cumulative counts of lifetime pig output. Average pig output per litter weaned was calculated by dividing those cumulative counts by the number of

parities at the time of removal. Estimates of annual productivity, such as the number of pigs weaned, the number of litters weaned and the number of NPD per year of herd life, were calculated, on both total and per mated female basis, by combining cumulative counts with herd days. These annual estimates were calculated considering only females that spent at least one entire year in the breeding herd. For instance, the number of pigs weaned per female per year of herd life (PW/F/YL) was calculated as follows:

PW/F/YL
= (Pigs weaned during herd life/herd days)
× 365 days

The criteria used for data collection, sampling and calculations of estimates of lifetime productivity have been described elsewhere (Lucia et al., 1999).

2.2. Reasons for removal

For each removal event (either cull or death), specific reasons for removal may or may not be recorded at the farm level. Overall, 42 removal reasons were recorded for the qualifying females. Those removal reasons were grouped into seven categories. 'Death' included all females that died or were destroyed for humane reasons, whether or not a specific reason for death was recorded. Culls attributed to metritis, prolapses, vulvar discharges, abscesses and disorders on multiple systems (cardiovascular, central nervous, gastrointestinal, respiratory or urogenital) were grouped into a category called 'disease/peripartum problems'. Although such culling reasons may not be necessarily related, they were grouped together because they represented a small proportion of the total. Culls attributed to 'locomotion' disorders referred to reasons such as injuries, lameness, unsoundness or downer syndrome. The 'litter performance' category corresponded to culls for farrowing productivity (total or born alive litter size), lactation or weaning performance, and farrowing difficulties. Culls for 'reproduction' were attributed to lack of observed oestrus, conception failure and failure to farrow (which included definitions such as negative pregnancy checking, not-in-pig sows and abortions). Females having culling attributed to 'old age' represented a single category. That definition can be very variable across herds (D'Allaire et al., 1987), since sows may be automatically culled after a certain number of parities or can be culled at early parities if they are considered too old for a specific parity number. The category classified as 'miscellaneous' included unthrifty females, females removed for marketing reasons or for behavioural problems, and those having culling reasons inconsistent with their biological data or unknown.

2.3. Statistical analyses

Frequency distributions and cross-tabulations were used to describe the occurrence of removal reasons and parity at removal. For those procedures, females having five or six parities at removal were grouped together, as well as those having seven or eight parities at removal, and those removed at parity nine or higher (9+). Descriptive statistics were generated for estimators of lifetime productivity. Analysis of variance was used to evaluate how estimates of lifetime productivity differed as a function of reason for removal, after adjustment for the effects of herd and month of female admission in the breeding herd. The analysed estimates were: parity at removal, herd days, percent of lifetime NPD, total number of pigs born during lifetime, number of pigs born alive during lifetime, number of pigs weaned during lifetime, total number of pigs born per litter weaned, number of pigs born alive per litter weaned, number of pigs weaned per litter weaned, and estimates of annual productivity (number of NPD per year of herd life, litters weaned per year of herd life, and pigs weaned per year of herd life). When dependent variables were available on either a total or per mated female basis, the latter were analysed, to adjust for differences in recording of entry events across herds. The resulting model was as follows:

$$Y_{ijkn} = \mu + R_i + H_j + M_k + e_{ijkn},$$

where Y_{ijkn} is the individual performance for a given female removed for the ith reason, in the jth herd, and that entered the herd in the kth month; μ is the overall mean; R_i is the effect of the ith removal reason; H_j is the effect of the jth herd; M_k is the

effect of the kth entry month; and e_{ijkn} is the random error. Differences in lifetime productivity across categories of removal reasons were tested using the Fisher's protected least significant difference test. Even though the effect of interaction between the herd and removal reason was initially included in the model, this effect was excluded from the final model due to lack of statistical significance. All analyses of variance were conducted through the General Linear Models procedure of SAS® (1988).

3. Results

Among all females having a recorded removal event, 92.6% were culled and 7.4% were removed due to death (Table 1). Females having an unknown or unrecorded reason for removal corresponded to 13.5% of the total, including 285 records in the 'death' category, and 788 records for culled females classified in the 'miscellaneous category'. Thus, only 51.8% of the females in the 'death' category had a recorded reason for death.

Culls attributed to 'reproduction' accounted for the largest proportion of removals (33.6%) across categories (Table 1). Nearly 36% of the reproduction-related culls occurred for parity-zero females. Conception failure was the most common reason for reproductive culling, followed by failure to farrow and lack of observed oestrus (Table 2). Culls for litter performance accounted for 20.6% of all removals (Table 1). Locomotion problems represented 13% of all removals (Table 1); nearly 55% of such culls were among females having 0–2 parities at removal. Females classified in the 'miscellaneous' category corresponded to 13.3% of all removals, but 788 of these females (74.2%) did not have a recorded reason for culling. Among those females having known culling reasons, 132 were unthrifty, 56 had behavioural problems, 44 were transferred out of the herd due to market reasons, and 42 had removal reasons inconsistent with their biological data or that occurred in a proportion too small to be reported alone. Almost 9% of all females had no reason for culling other than old age (Table 1).

Nearly 19% of the removals occurred for parity-zero females, while almost 15% occurred for females removed at parity one (Table 1). Among the parity-zero females, nearly 65% were culled for 'reproduction' and 14% were culled for 'locomotion' problems (Fig. 1). For females having one parity at removal, reproductive reasons and locomotion disorders accounted for 43% and 18% of the removals, respectively. Litter performance was the most common removal reason for females having four to six parities, whereas old age was the most common reason for removal among females having more than seven parities.

Mean herd life for all females was 582.7 herd days. Females removed at parity zero spent, on average, 119.9 days in the breeding herd. Mean herd life for females removed at parity one or higher was 668 days, and was 691 days when estimated on a per mated female basis (Table 3). Mean parity at removal for all females was 3.3. The proportion of lifetime NPD for all females was 36.4%, and was 25% when estimated on a per mated female basis. Without considering females removed at parity zero (having

Table 1
Frequency (%) of removal reasons by parity at removal

Reason	Parity at removal[a]								*n*	(%)
	0	1	2	3	4	5–6	7–8	9+		
Reproduction	35.9	19.3	11.5	9.8	8.0	10.7	3.8	1.0	2680	33.6
Litter performance	–	10.5	13.9	14.7	17.1	25.1	13.9	4.7	1644	20.6
Miscellaneous	18.5	15.9	13.0	13.4	12.6	17.4	7.4	1.8	1062	13.3
Locomotion	20.4	19.8	15.0	13.5	10.2	14.0	5.6	1.5	1054	13.2
Old age	0.4	0.1	0.4	1.3	2.9	23.5	43.4	28.0	694	8.7
Death	14.2	14.1	16.1	14.4	13.6	17.5	7.5	2.7	590	7.4
Disease/peripartum	12.9	15.3	13.7	10.8	14.9	22.5	6.4	3.6	249	3.1
Total (%)	18.7	14.9	12.1	11.4	10.9	17.0	10.4	4.5	7973	100.0

[a] Frequencies in cells add to 100% for each category of removal reason.

Table 2
Reasons for removal within categories of culling reasons

Reason	Records	Frequency (%)[a]	Proportion of total (%)[b]
Reproduction			
Conception failure	1065	39.7	13.4
Failure to farrow	892	33.3	11.2
Lack of observed heat	723	27.0	9.1
Total	2680	100.0	33.6
Litter performance			
Farrowing productivity	1121	68.2	14.1
Lactation–weaning productivity	393	23.9	4.9
Difficult farrowing	130	7.9	1.6
Total	1644	100.0	20.6
Locomotion			
Lameness	533	50.6	6.7
Unsoundness	231	21.9	2.9
Injury	206	19.5	2.6
Downer syndrome	84	7.9	1.1
Total	1054	100.0	13.2
Disease/peripartum problems			
Prolapse	88	35.3	1.1
Vulvar discharge	25	10.0	0.3
Multiple systems	22	8.8	0.3
Gastrointestinal	21	8.4	0.3
Respiratory	18	7.2	0.2
Ulcer	18	7.2	0.2
Urogenital	17	6.8	0.2
Central nervous	16	6.4	0.2
Metritis	15	6.0	0.2
Other[c]	9	3.6	0.1
Total	249	100.0	3.1

[a] Frequency within category.
[b] Frequency considering all removals ($n=7973$).
[c] Includes abscess, cardiovascular conditions and skin-cutaneous conditions.

spent the entire herd life in non-productive activities), mean lifetime NPD was between 18 and 21.6% (Table 3).

Parity number was higher and herd life was longer for females culled for Old age ($P<0.01$) than for those having removals attributed to other reasons (Table 4). However, the proportion of lifetime NPD for females culled either for old age or for litter performance did not differ ($P>0.01$). Females culled for reproduction and locomotion disorders achieved shorter herd life and fewer parities than those removed for other reasons ($P<0.01$). Mean herd life did not differ between those two categories ($P>0.05$), but mean parity at removal was higher for females culled for locomotion problems than for those culled for reproduction ($P<0.01$). Females culled for reproduction accumulated the largest proportion of lifetime NPD across categories ($P<0.01$).

Average pig output accumulated during herd life was 45 pigs born, 41.3 pigs born alive and 35.9 pigs weaned (Table 3). Mean lifetime pig output per litter weaned was 10.7 pigs born, 9.8 pigs born alive and 8.7 pigs weaned. Generally, females culled for old age produced the largest pig output (both cumulative and per litter weaned) across categories of removal reasons (Tables 5 and 6). In contrast, females culled for either reproduction or locomotion disorders produced the lowest cumulative pig output ($P<0.01$), whereas females culled for litter performance produced the lowest pig output per litter weaned ($P<0.05$).

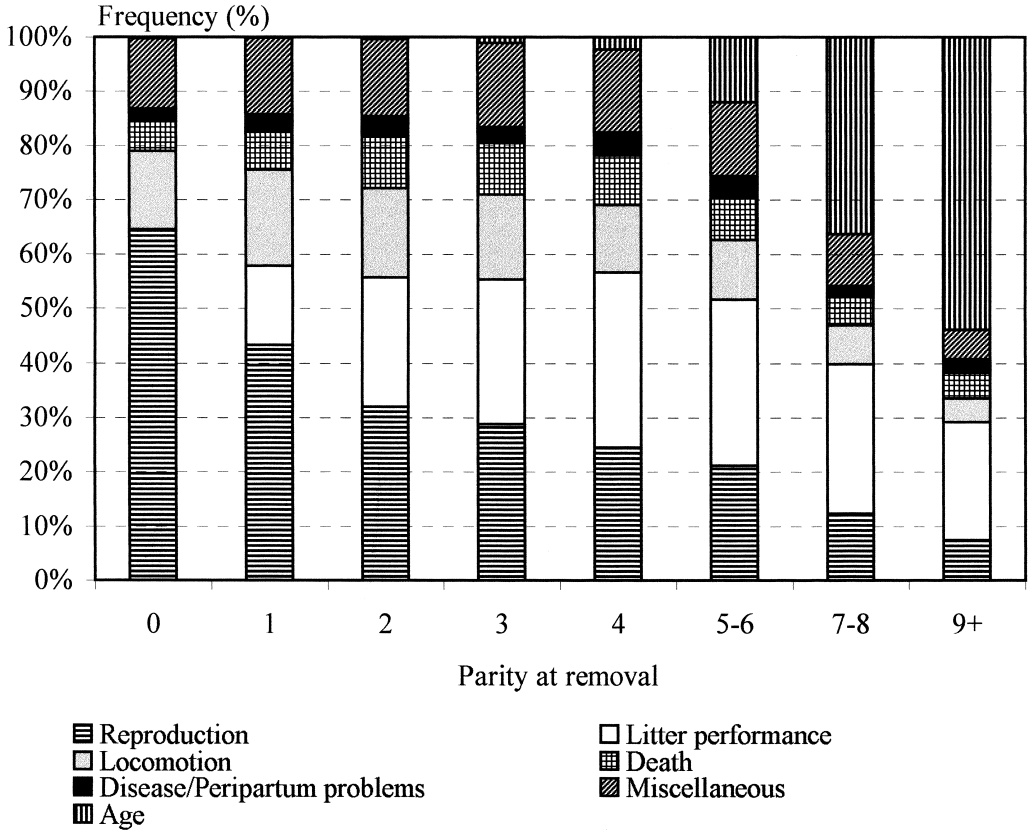

Fig. 1. Reason-specific proportions of removal by parity at removal.

Females having herd life at least one year long produced 2.16 to 2.23 litters and nearly 19 weaned pigs, and wasted 60 to 70 NPD per each year spent in the breeding herd (Table 3). Annual productivity was highest for females culled for old age (Table 7) and lowest for those culled for reproductive failure ($P<0.05$).

4. Discussion

The large frequency of culling observed in this study for reproductive failure at low parities, which represented approximately one third of all removals, is in agreement with other studies (Dagorn and Aumaitre, 1979; D'Allaire et al., 1987; Dijkhuizen et al., 1989; Stein et al., 1990; Patterson et al., 1996). In addition, however, the present study quantified the NPD accumulated during the herd life of females removed for reproductive failure. NPD accumulation is negatively associated with annual reproductive efficiency measured by the number of pigs weaned per female per year, as already characterised at the herd level (Wilson et al., 1986; Polson et al., 1990; Dial et al., 1992). When measured over herd life, the negative association between NPD and female reproductive efficiency is better characterised when NPD are expressed as proportions of herd life wasted in non-productive activities rather than by cumulative counts (Lucia et al., 1999). That occurs because females having longer herd life accumulate more days in both productive and non-productive periods during each parity interval in comparison with those having shorter herd life. Females culled for reproduction reasons achieved a lower parity number and spent a higher proportion of herd life in non-productive activities than those removed for any other reason. Since females culled for reproductive

Table 3
Descriptive statistics for estimates of lifetime productivity of female pigs

Parameter	Mean	Median	SD
Herd life and cumulative performance[a]			
Herd days	691.0	640.5	357.3
Herd days/mated female	668.3	615.0	359.4
Non-productive days (%)	21.6	17.6	15.9
Non-productive days/mated female (%)	17.9	13.7	15.1
Total born/lifetime	45.0	40	29.7
Born alive/lifetime	41.3	37	27.1
Pigs weaned/lifetime	35.9	32	23.3
Lifetime performance per litter			
Total born/litter weaned	10.7	10.8	2.2
Born alive/litter weaned	9.8	10.0	2.1
Pigs weaned/litter weaned	8.7	8.9	1.8
Productivity per year of herd life[b]			
Non-productive days/year of herd life	69.9	56.4	52.0
Non-productive days/mated female/year of herd life	60.0	45.7	50.5
Litters weaned/year of herd life	2.16	2.2	0.4
Litters weaned/mated female/year of herd life	2.23	2.3	0.4
Pigs weaned/year of herd life	18.7	19.2	4.3
Pigs weaned/mated female/year of herd life	19.3	19.8	4.3

[a] $n=6303$ females having at least one parity at removal.
[b] $n=4887$ females that spent at least one year in the breeding herd.

Table 4
Parity at removal, herd life and lifetime non-productive days (NPD) by removal reason[a]

Reason	*n*	Parity at removal	Herd days[b]	NPD (%)[b]
Death	580	3.2 ± 0.09^{ef}	533.8 ± 14.00^{e}	25.2 ± 0.92^{e}
Disease/peripartum	241	3.3 ± 0.14^{e}	544.6 ± 21.60^{e}	18.0 ± 1.43^{d}
Litter performance	1568	4.4 ± 0.07^{d}	680.3 ± 9.79^{d}	10.0 ± 0.63^{c}
Locomotion	1039	2.6 ± 0.07^{g}	454.2 ± 11.00^{f}	23.1 ± 0.75^{e}
Miscellaneous	1010	2.9 ± 0.08^{f}	521.8 ± 11.70^{e}	26.9 ± 0.79^{f}
Reproduction	2641	2.1 ± 0.05^{h}	441.4 ± 7.36^{f}	42.2 ± 0.63^{g}
Old age	687	7.4 ± 0.09^{c}	1133.2 ± 13.34^{c}	11.4 ± 0.86^{c}

[a] All estimates were calculated including parity-zero females.
[b] Estimates calculated on a per mated female basis.
[c,d,e,f,g,h] Least square means±standard errors in the same column having unequal superscripts differ across categories of removal reasons ($P<0.01$).

failure also produced fewer pigs weaned, both per year of herd life and during total herd life, than females removed due to other reasons, it can be inferred that minimisation of removals for reproductive failure is critical to optimise lifetime reproductive efficiency. Thus, reproductive management practices should be directed to reduction of NPD accumulation at early reproductive cycles, which could be achieved by breeding unmated females as early as possible, and by tightening oestrus detection and pregnancy checking (Dial et al., 1992). The weaning-to-first service interval of primiparous females should also be minimised, which requires optimisation of feed intake during lactation and adjustment for seasonal and environmental risk factors (Koketsu et al., 1996).

According to some studies, female maintenance in the breeding herd would be profitable for up to nine parities (Dijkhuizen et al., 1986; Huirne et al., 1991). That parity number is higher than the mean of 7.4

Table 5
Cumulative lifetime pig output by removal reason

Reason	*n*	Total born/lifetime	Born alive/lifetime	Pigs weaned/lifetime
Death	496	40.3±1.16[c]	36.9±1.06[c]	30.7±0.91[c]
Disease/peripartum	210	42.9±1.76[c]	38.6±1.62[c]	33.1±1.38[c]
Litter performance	1568	46.6±0.77[b]	42.2±0.70[b]	35.6±0.60[b]
Locomotion	828	36.5±0.93[d]	33.4±0.86[d]	28.7±0.73[d]
Miscellaneous	824	41.1±0.99[c]	37.7±0.91[c]	32.1±0.78[c]
Reproduction	1690	35.5±0.68[d]	32.7±0.62[d]	29.4±0.53[d]
Old age	687	86.6±1.03[a]	79.8±0.95[a]	68.2±0.81[a]

[a,b,c,d] Least square means±standard errors in the same column having unequal superscripts differ across categories of removal reasons ($P<0.05$).

Table 6
Lifetime pig output per litter weaned (LW) by removal reason

Reason	*n*	Total born/LW	Born alive/LW	Pigs weaned/LW
Death	496	10.9±0.09[b]	10.0±0.09[b]	8.3±0.08[c]
Disease/Peripartum	210	10.9±0.15[b]	9.9±0.14[b]	8.7±0.11[b]
Litter performance	1568	10.5±0.06[c]	9.4±0.06[c]	7.9±0.05[d]
Locomotion	828	10.9±0.07[b]	10.0±0.07[b]	8.7±0.06[b]
Miscellaneous	824	10.7±0.08[b]	10.0±0.07[b]	8.5±0.04[b]
Reproduction	1690	10.7±0.06[b]	9.9±0.05[b]	9.1±0.04[a]
Old age	687	11.6±0.09[a]	10.7±0.08[a]	9.0±0.07[a]

[a,b,c,d] Least square means±standard errors in the same column having unequal superscript differ across categories of removal reasons ($P<0.05$).

Table 7
Lifetime performance per year of herd life by removal reason[a]

Reason	*n*	NPD/year[b]	Litters weaned/year	Pigs weaned/year
Death	372	64.1±2.28[f]	2.20±0.02[e]	18.4±0.21[ef]
Disease/Peripartum	153	53.9±3.53[e]	2.26±0.02[d]	19.5±0.32[d]
Litter performance	1282	44.7±1.45[d]	2.33±0.01[c]	18.8±0.13[de]
Locomotion	553	61.2±1.94[ef]	2.21±0.01[e]	19.3±0.18[de]
Miscellaneous	633	72.1±1.94[g]	2.13±0.01[f]	18.3±0.18[f]
Reproduction	1212	99.4±1.34[h]	1.93±0.01[g]	17.6±0.12[g]
Old age	682	39.6±1.80[c]	2.36±0.01[c]	21.3±0.16[c]

[a] Estimates calculated on a per mated female basis, including only sows that spend at least one year in the breeding herd.
[b] NPD=Non-productive days.
[c,d,e,f,g,h] Least square means±standard errors in the same column having unequal superscripts differ across categories of removal reasons ($P<0.05$).

parities reported in this study for females culled for old age. Thus, it can be implied that most of the females included in this study were removed from the herd without producing a weaned pig output large enough to amortise any costs that they accumulated during their herd life. As opportunities for profit related to production of weaned pigs are delayed during non-productive periods, NPD accumulation results in additional opportunity costs (Polson et al., 1990; Huirne et al., 1991; Schukken et al., 1994). Since death is the only type of removal that is truly involuntary due to its inevitable nature, all culls are based on voluntary decisions made at any critical event during a female's herd life (e.g., a return to oestrus, a weaning). Ideally, such decisions would be financially based, taking into account the

current productivity of a given female and the potential performance of a replacement (Dijkhuizen et al., 1986; Huirne et al., 1991). In the case of reproductive failure, decision-makers may consider that, at a given point in time, it would be more profitable to replace rather than to retain any further a female that accumulated a large amount of NPD early in life and that may continue to be inefficient subsequently. On the other hand, decision-makers may set a target for maximum life expectancy when a large pig output is already guaranteed, after which culling would be a function of parity number. Among the females analysed in this study, those culled for old age achieved the highest lifetime productivity, since they produced more pigs weaned per year spent in the herd and during herd life than those having other removal reasons. Nevertheless, that high level of performance should not be over-emphasised because females culled for old age are probably not representative of an average female, as they corresponded to less than 9% of the total removed females. In comparison with females culled for litter performance, those culled for old age produced three extra litters during a herd life longer by nearly 1.2 years, even though the percent of lifetime NPD accumulated by females in those two categories of removal reasons did not differ. Females culled for litter performance produced on average 4.4 litters during herd life, which is in agreement with studies that reported that reduced litter size is not a major risk factor for removal of low-parity females (Clark and Leman, 1987; D'Allaire et al., 1987).

Culls for locomotion problems tended to be more common for low-parity females, as reported elsewhere (Sehested and Schjerve, 1996). However, locomotion disorders may be more prevalent than removals due to locomotion problems, since females having locomotion problems may have culling attributed to other reasons as well. Females having locomotion problems may experience some inability to mate under natural conditions, which may influence both their subsequent fertility and litter size. Those females may also reduce feed consumption and produce less milk during lactation, which may lead to poor litter performance and increased piglet mortality.

A potential limitation of this study is the fact that definitions of removal reasons are not standardised. Validation of removals for reproductive failure would probably reveal some inaccuracy in culling criteria, as reported by Einarsson et al. (1974) who found that a substantial proportion of genital organs of gilts culled for anoestrus actually showed evidence of active corpora lutea or pregnancy. True validation of reasons for removals for death, disease and peripartum and locomotion problems could only be accomplished by necropsy and clinical or laboratory evaluation. Validation of removals for litter performance or old age through methods other than analysis of retrospective records is likely unfeasible, since those culls are based on decisions that are management-dependent and potentially subjective. Another potential limitation of this study is the fact that extrapolation of its results may be limited to herds having stable inventories and good quality data during long time periods. However, this study analysed estimates of reproductive performance estimated longitudinally during the herd life of a large number of females followed over a long time period, which is an advantage that is probably not possible to achieve under experimental conditions.

5. Conclusions

Breeding inventories are commonly made up of a large proportion of young females, which are more prone to suffer from reproductive failure and to accumulate NPD at early reproductive cycles before farrowing for the first time or within the interval between the first and the second parities. The majority of the females removed from the breeding herd are culled for reproductive failure, thus having short herd life and sub-optimal reproductive efficiency, since their weaned pig output during herd life is lower than that for females having other reasons for removal. As the proportion of NPD during herd life was highest for females culled for reproductive failure, minimisation of NPD in low-parity females can be considered critical to optimise lifetime productivity, which can be achieved by applying good management for oestrus detection and pregnancy checking. However, without close attention to areas such as nutrition and genetics, such practices may in fact increase female removal at low parities, since manifestations of reproductive failure would be

identified more easily. On the other hand, if management interventions planned to improve female life expectancy are based solely on setting more flexible targets for culling rates, the most likely consequence would be a higher retention of inefficient females, which could reduce overall herd productivity.

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