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Reproductive Performance Among Sows Group-Housed During Late Lactation

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Hultén F, Lundeheim N, Dalin A-M, Einarsson S: Reproductive performance among sows group-housed during late lactation. Acta vet. scand. 1998, 39, 237-250. – Four farms (540 sows) that group-housed sows from 2 weeks of lactation until weaning (G-farms) and 3 farms (300 sows) – used as controls – that kept the sows individually penned throughout the 5- to 6-week-long lactation period (C-farms) were compared in terms of reproductive performance. All sows were crossbred Swedish Yorkshire× Swedish Landrace. Sows were kept in groups in the breeding section and were also grouped on deep litter in the dry-sow section on all farms. Batchwise farrowing routines were used on all farms, and batch size ranged between 8 and 22 sows. Fertility and culling data were collected in connection with monthly visits to the farms for 16 months. Among the older (≥ 5th parity) sows, litter sizes were significantly ($p = 0.02$) smaller in the G-farm group compared with the C-farm group. The percentage of sows mated within 10 days post weaning was lower ($p<0.001$) in the G-farm group than in the C-farm group, with the difference being most evident among the older (≥ 5th parity) sows. The frequency of repeat breeders among primiparous sows was similar in the 2 housing systems, but among the multiparous sows repeat-breeder frequency was higher ($p = 0.04$) in the G-farm group than in the C-farm group. In both groups, repeat-breeder frequency seemed to be highest from July to September. Repeat breeding/failure to farrow was a common reason for culling in the G-farm group. These results indicate that reproductive performance was impaired in the group-housing system. This impairment could have been due partly to the occurrence of lactational oestrus, which makes it difficult to maintain adequate routines for oestrous detection and mating/insemination.

housing system; fertility; litter size; repeat breeding; culling.

Introduction

Group-housing systems for lactating sows increase welfare in the sense that they enable the sow to perform more of her natural behaviours (*Signoret et al.* 1975, *Stolba & Wood-Gush* 1980). Stereotyped behaviour is less frequent among group-housed sows (*Arellano et al.* 1992), and the health status of these sows at time of weaning is similar to that of conventionally housed sows (*Hultén et al.* 1995b). However, to be competitive in the pig industry, a specific housing system must not only offer high welfare standards, but must also make it possible for the sow to fully express her genetic potential for production. To achieve high productivity, litters should be large with few stillborn piglets; milk production should be sufficient; the sows should show good mothering behaviour and have a short weaning-to-mating interval, and the incidence of repeat breeding should be low. Together, these characteristics should result in a large number of well-nourished piglets produced per sow and year. Mother-offspring contact during lactation is reduced in group-housing systems (*Hultén et al.* 1995b). Consequently, lactational oestrus occurs in a large, but variable, proportion of the group-housed sows (*Hultén et al.* 1995a). Sow age seems to have a strong influence on the occurrence of oestrus during lactation (*Hultén et al.* 1995a). Since batchwise farrowing routines are widely used today, for hygienic and epidemiological reasons, sows are not bred during lactation. Thus, the occurrence of lactational oestrus is a disadvantage because it counteracts efforts to minimise the length of the breeding period after weaning (*Hultén et al.* 1995a). However, it has yet to be determined if litter size is affected among sows kept in a housing system where lactational oestrus occurs frequently but all sows are bred after weaning.

Previous reports indicate that there is seasonal variation in the occurrence of lactational oestrus among group-housed sows (*Petchey & Jolly* 1979). Similarly, reduced fertility among conventionally housed sows during summer/autumn, manifested by prolonged weaning-to-breeding intervals, especially among primiparous sows, and a reduced farrowing rate, have previously been noted (*Linde et al.* 1984, *Love et al.* 1993). Information on seasonal and age-related effects on fertility among group-housed sows managed according to a batchwise breeding strategy is scarce. Finally, culling data from group-housing systems have not previously been presented. The analysis of such data could reveal more about the effects of this housing system on sow fertility.

The objectives of the present study were to evaluate fertility and productivity in a group-housing system for lactating sows by analysing culling data as well as age- and season-related effects on litter traits, weaning-to-breeding interval and the incidence of repeat breeders.

Materials and methods

During a 16-month period fertility data were collected from 4 farms where the sows farrowed in individual pens and were group-housed from 2-3 weeks of lactation until weaning (G-farms), and from 3 farms, used as controls, where the sows were kept individually penned throughout the lactation period (C-farms). The farms have previously been described in detail (*Hultén et al.* 1995b). Herd size ranged from 75 to 220 sows in the G-farm group and from 65 to 140 in the C-farm group. At the start of the study there was a total of 540 sows in the G-farm group and 300 in the C-farm group. These numbers remained quite stable throughout the study. All sows were crossbred Swedish Yorkshire×Swedish Landrace. On all farms, batchwise farrowing routines were used, and the interval between batches was 2-6 weeks. Batch size varied from 8 to 22 sows. Sows were moved to the farrowing pens a few days before expected farrowing. On some farms, sows were crated for 1-2 days at the time of farrowing, but on most farms they were kept loose in the pen (average area of 7.2 m^2). On all farms, fostering was practised within the same batch to even out differences in litter size. In the G-farm group, sows and their litters were moved to a group-housing section when the last litter born in the same batch of sows was at least 10 days old. The group-housing section allowed 6-8 m^2 per sow and consisted of isolated buildings with deep straw litter on a concrete floor. In the group-housing section (G-farms) food was provided either in dry-food self-feeders or in troughs. The lactation period was 5-6 weeks, during which time the sows had no boar contact. On all farms at time of weaning, sows were moved to the breeding section where they were kept in groups. During the breeding period on the C-farms, group size was 4-10, whereas on the G-farms it varied between 8 and 22 because the groups were kept intact from the lactation to the breeding section. Oestrous detection was performed twice daily in the presence of a boar. The boars, kept in pens adjacent to the sow pens, were led outside the sow pens and occasionally allowed to mix with the sows for a short period. One G-farm used Duroc boars, whereas the others used Hampshire boars. In the G-farm group 20% of the sows were naturally mated, 51% were artificially inseminated, and 29% were both mated and inseminated. Corresponding figures for the C-farm group were 21%, 33% and 46%, respectively. Most sows were mated/inseminated twice. On one C-farm, sows were moved to the dry-sow section within the first week after mating, whereas on the other 2 C-farms sows were not moved until they were detected pregnant. The latter routine was also used on 3 of the 4 G-farms. On the remaining G-farm sows were moved 3 weeks after weaning. All farms kept dry sows indoors in groups of 20-40 on deep straw litter bedding. On one G-farm sow groups were kept intact throughout gestation, whereas on the other farms, groups were dynamic.

On 6 farms, replacement gilts were introduced at 25 kg weight. They were fed according to the Swedish breeding-stock standard and were mated in connection with their second or third oestrus. On one C-farm, gilts in late pregnancy were bought for replacement.

On 2 of the G-farms and on one of the C-farms liquid feeding was practised (grain, commercial premix and whey), whereas on the other farms the food was given dry. During gestation, on all farms the daily food allowance was 25-26 MJ/sow (120-170 g crude protein/kg dry matter). On one G-farm transponder feeding was practised, whereas on the other farms dry sows were fed twice daily. The food ration was gradually increased beginning one to 2 days after farrowing, and the maximum ration was reached between days 10 and 14 of lactation. The average daily food ration at that time was 88-90 MJ (150-160 g crude protein/kg dry matter) per sow with 10 piglets. In the C-farm group this ration level was maintained throughout lactation, whereas in the G-farm group sows were fed *ad libitum* during the group housing period.

From weaning to mating, sows were fed 60-80 MJ daily, and after mating the ration was decreased to 25-26 MJ/sow. However, on one G-farm sows were allowed the higher ration until 2 weeks after mating, and in 2 G-farms sows were fed a low ration on the day of weaning.

During the study period, the farms were visited each month by the same veterinarian, and records were collected concerning litter size, number of stillborn piglets (determined at first contact with the sow after farrowing), length of the lactation period, weaning-to-mating interval, breeding strategy, repeat breeding, farrowing interval and cullings. The data were continuously checked, and additional information obtained from the farmers helped to minimise the occurrence of errors or missing values. A sow was considered to be a repeat breeder if one of the following criteria was fulfilled: 1) repeatedly mated, with more than 7 days in between each mating, 2) more than 121 days from first mating after weaning to consecutive farrowing, 3) slaughtered due to return to oestrus or abortion. Only 2 sows in the G-farm group and one sow in the C-farm group were slaughtered due to abortion.

Statistical analysis

Statistical analyses were carried out using the SAS-procedures (*SAS Institute Inc.* 1985). Litter size, number of stillborn piglets and weaning-to-mating interval were analysed with the MIXED-procedure according to a model including the fixed effects of housing system (2), age-group (3 classes: 1st parity, 2nd-4th parity, ≥5th parity), the interaction between housing system and age-group, and the regression on length of the previous lactation period, within age-group. The effects of farm (7), batch (165) and sow (1120) were included in the model and considered as random terms. Parity number and length of lactation period were analysed with the same statistical model, excluding the effect of age-group. The chi-square test was used to analyse differences between and within housing systems, in the proportion of sows mated within 10 days post weaning, the distribution of sows mated within 10 days after weaning and the percentage of repeat breeders. In addition, within the G-farm group differences in the size of the subsequent litter among sows bred within or later than 10 days post weaning were tested with the MIXED-procedure according to a model including the effects of time of breeding (≤10 days post weaning or >10 days post weaning), age-group (3 classes: 1st parity, 2nd-4th parity, ≥5th parity) and the interaction between age group and time of breeding. Farm, batch and sow were included in the model and considered as random terms. Seasonal variation in repeat breeder frequency was analysed by creating 4 seasonal classes based on the winter/summer solstice. P-values, which denote the probability of having obtained our data when the null hypothesis is true, are given in the text. P-values ≤0.05 were considered statistically significant.

Results

The study includes information from 1 120 sows and 2 440 farrowings. Thus, on average, 2.2 farrowings were recorded from each sow. The average parity number was 3.9 (±2.0) in the G-farm group and 3.4 (±1.8) in the C-farm group, and there was no significant difference between the 2 groups ($p = 0.26$). Similarly, the length of the lactation period was about the same ($p = 0.55$) in the G-farm group (36.8 ±6.9 days) and the C-farm group (35.0±5.2 days).

Litter size

As shown in Table 1, the average total litter size at birth was about the same in the 2 groups. Moreover, within both groups litter size increased significantly with parity number. Among the primiparous and 2nd-4th parity sows, litter size was similar in the 2 groups. By contrast, litter size among the older (≥5th parity) G-farm sows was significantly smaller than among the older C-farm sows. The average total number of stillborn piglets and the number of stillborn piglets within age groups were similar in the 2 housing systems (Table 1). In both groups, the number of stillborn piglets seemed to increase with parity number .

Proportion of sows mated within 10 days post weaning

In the G-farm group, some sows that showed oestrus while kept in groups during lactation were inseminated, although this was not the established practise on the farms. Thus, 2% of the G-farm sows were mated before weaning. None of these sows were primiparous, whereas 58% were older sows (≥5th parity).

Including the sows mated before weaning, the proportion of sows mated within 10 days post weaning was significantly smaller in the G-farm group than in the C-farm group (Table 2). However, this difference only concerned multiparous sows. Within the G-farm group, the proportion of sows mated within 10 days after weaning was significantly lower among the older (≥5th parity) sows compared with the primiparous and 2nd-to 4th parity sows. By contrast, in the C-farm group no difference between age-groups was noted. Among the primiparous G-farm sows, the subsequent litter size was significantly ($p = 0.004$) smaller for sows mated within 10 days post weaning (10.8 piglets) compared with those mated later (12.6 piglets). By contrast, these differences did not occur among the multiparous sows.

Table 1. Average total litter size at birth (born alive and stillborn) and number of stillborn piglets, within parity-number group.

	G-farm group	C-farm group	P-values
No. of sows	717	403	
Average litter size at birth	11.5	11.8	0.16
Within parity number:			
1	10.4[a]	10.4[a]	0.92
2-4	11.9[b]	12.0[b]	0.53
≥ 5	12.4[c]	13.0[c]	0.02
Average no. of stillborn piglets	0.66	0.61	0.65
Within parity number:			
1	0.60[a]	0.58[ab]	0.89
2-4	0.59[a]	0.49[bc]	0.42
≥ 5	0.79[b]	0.75[a]	0.76

[a, b, c] Values in a column with no superscript in common differ significantly ($p<0.05$).

Table 2. Percentage of sows mated within 10 days after weaning.

	G-farm group	C-farm group	P-values (between groups)
Total	84.4 (79-93) [1)]	95.5 (95-96)	<0.001
Parity no.			
1	88.4[a)] (76-97)	91.9[a)] (91-94)	0.35
2-4	87.4[a)] (85-97)	96.4[a)] (94-98)	<0.001
≥ 5	76.7[b)] (62-95)	95.6[a)] (95-100)	<0.001

[a,b,c] Values in a column with different superscripts differ significantly ($p<0.05$).
[1)] Farm range given within parentheses.

During the winter months (December to February) and in September, the proportion of older (≥5th parity) G-farm sows mated within 10 days after weaning was significantly lower compared with the mean for all C-farm sows (Fig. 1). Similarly, significant differences between 2nd-4th parity G-farm sows and the C-farm sows occurred in June, September and December. Relevant comparisons could not be performed with the primiparous sows as group size within each month was too small (≤4 sows).

Weaning-to-mating interval

Among sows that were mated within 10 days after weaning, the interval from weaning to mating was similar ($p = 0.61$) for the G-farm (4.8 days), and C-farm (5.0 days) groups. Moreover, there were no significant differences between the 2 groups among primiparous, 2nd-4th parity and ≥5th parity sows. However, within both groups, primiparous sows had a significantly ($p<0.05$) longer weaning-to-mating interval compared with the multiparous sows. The dis-

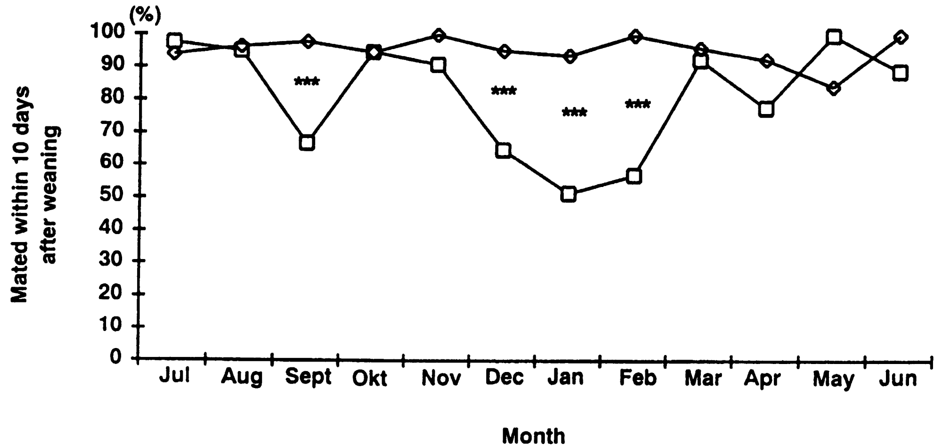

Figure 1. The percentage of all C-farm sows, and of the older (≥ 5th parity) G-farms sows, mated within 10 days after weaning, within month.

—□— Older (>5th parity) grouphoused sows. —◇— Individually housed sows. *** difference is statistically significant ($p<0.001$) between housing systems within month.

tribution of the sows mated within 10 days after weaning, excluding those mated before weaning, differed between groups. In the C-farm group, 92% of the sows were mated on days 4 to 6 after weaning, whereas only 81% of the G-farm sows were mated within the same period ($p<0.001$). In addition, 13% of the G-farm sows were mated within 3 days after weaning, whereas only 3% of the C-farm sows were mated within this period ($p<0.001$).

Repeat breeders

As shown in Table 3, the total average repeat breeder frequency was about twice as high in the G-farm group compared with in the C-farm group. Among primiparous sows, the frequency of repeat breeders was about the same in the 2 housing systems, whereas among multiparous sows the percentage of repeat breeders was significantly higher in the G-farm group than in the C-farm group. Within the G-farm group, the frequency of repeat breeders was about the same for all age-groups, whereas within the C-farm group repeat breeders were significantly more common among the primiparous sows than among the multiparous sows. Differences between herds within a given type of housing system were significant ($p<0.001$) in the G-farm group but not in the C-farm group. The interval from first mating after weaning to subsequent farrowing was calculated for the repeat breeders. In the G-farm group, 51.5% of the repeat- breeder sows appeared to have completed at least 2 oestrous cycles before being successfully bred (>156 days between first mating after weaning and farrowing), whereas the corresponding figure for the C-farm group was 42.3%. In the G-farm group, there were no significant differences between repeat-breeder sows and sows conceiving after their first mating in total litter size at birth or number of stillborn piglets, neither in the litter preceding the occurrence of repeat breeding nor in the subsequent litter. The total size of the litter following the occurrence of repeat breeding was significantly larger for sows in the C-farm group,

Table 3. Percentage of repeat breeders.

	G-farm group	C-farm group	P-values (between groups)
Total	16.6 (9.3-28.4)$^{1)}$	8.6 (6.9-11.6)	<0.001
Parity no.			
1	16.3$^{a)}$ (6.5-29.4)	20.2$^{a)}$ (12.9-26.7)	0.46
2-4	16.4$^{a)}$ (10.0-27.2)	5.3$^{b)}$ (4.1- 7.1)	≮0.001
≥5	17.3$^{a)}$ (8.5-42.1)	8.1$^{b)}$ (4.7-16.7)	<0.004

^{a,b} Values in a column with different superscripts differ significantly ($p<0.05$).
$^{1)}$ Farm range given within parentheses.

Table 4. The distribution of different breeding strategies among repeat-breeder sows and sows conceiving after first mating (normal), within the G-farm group and C-farm group respectively (%).

	G-farm group		C-farm group	
	Normal	Repeat breeder	Normal	Repeat breeder
AI	47.9	65.7	31.4	44.7
Mated	19.3	22.1	21.5	20.6
AI and mated	32.8	12.2	47.1	34.7
Total	100	100	100	100

compared with sows conceiving after their first mating, but in this group the number of repeat breeders was small (27). As shown in Table 4 the breeding strategies at first mating after weaning differed somewhat between sows that later showed repeat breeding and those that conceived after first mating. In both groups, the use of solely artificial insemination seemed more common among repeat-breeders sows than among sows conceiving after first mating. In both groups, the frequency of repeat breeders seemed highest during the summer/autumn period (21/6-20/9) (Fig. 2). However, in the G-farm group the repeat-breeder frequency was also very high during the winter/spring period. During both these periods, the percentage of repeat breeders differed significantly between the 2 groups.

Reasons for culling

The total annual removal rate was 34.5% in the G-farm group and 48.5% in the C-farm group. The mean parity number for culled sows was higher in the G-farm group (4.9) than in the C-farm group (3.7). The proportion of sows culled owing to mastitis was very high in the C-farm group (32.3%). The high culling rate can be attributed to the mastitis control programme established in 2 of the C-farms during the period the study was performed (Hultén et al 1995b). In contrast, only 7.5% of the cullings in the G-farm group were due to mastitis. Mean parity number in sows culled for mastitis was 3.6 and 2.8 in the G- and C-farm group respectively. Excluding sows culled due to mastitis, the annual removal rate in the C-farm group was 38.2% The reasons for culling are presented for the G- and C-farm groups in Table 5. Propor-

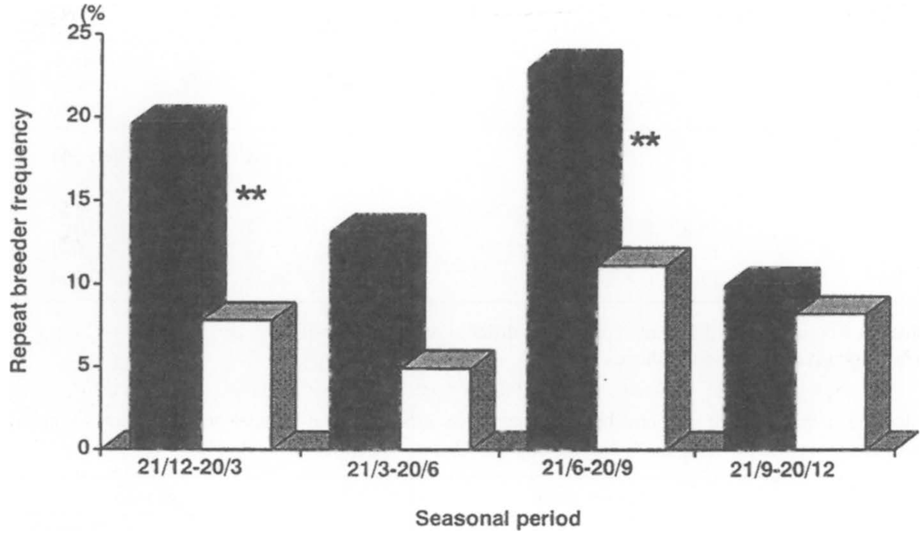

Figure 2. The percentage of repeat breeders within season class.
** Significant difference between groups (p<0.01). ■ G-sows. □ C-sows.

tion rates were calculated with sows culled for mastitis either included, or excluded (figures given in brackets). Comparisons between the 2 housing systems, with regard to figures calculated with sows culled for mastitis excluded, showed that reproductive failure was the reason for culling for almost half of the culled sows in the G-farm group, whereas in the C-farm groups fewer sows were culled for this reason. "Repeat breeding/failure to farrow" was the most common reproductive disorder in both groups. The proportion of sows culled due to locomotor disturbances was higher in the C-farm group than in the G-farm group. Inadequate mothering behaviour – which includes pure aggressiveness or just inattentiveness toward their own offspring – was a somewhat more frequent reason for culling in the G-farm group than in the C-farm group. No G-farm sows were culled owing to thinness. Miscellaneous causes include obesity, wounds, dystocia and uterine or rectal prolapse.

Discussion

In both housing systems, the average litter size among primiparous sows was similar to previously reported figures (*Sterning & Lundeheim* 1995, *Neil & Ogle* 1996). Moreover, first-parity litter size was the same in the 2 groups, probably because the routines used for keeping replacement gilts were similar in almost all herds. Litter size and number of stillborn piglets increased with parity number, in agreement with several previous reports (*Randall & Penny* 1970, *Esbenshade et al.* 1986, *Gatel et al.* 1987, *Neil & Ogle* 1996). However, in the present study litter size was significantly larger among the older (≥ 5th parity) C-farm sows compared with the older G-farm sows. Our finding that among these sows the number of stillborn piglets was similar in the 2 housing systems indicates that the difference was due to a higher number of piglets born alive in the C-farm group. Previous studies have indicated that feeding level during lactation is positively

Table 5. Proportional distribution of reasons for culling in ghe G- and C-farm group respectively (%).

	G-farm group	C-farm group
No. of sows	195 (211)	109 (161)
Reproductive failure		
– Repeat breeding/failure to farrow	38.5 (35.5)	20.2 (13.7)
– Abortion	2.6 (2.4)	1.8 (1.2)
– Anoestrus/weak oestrous symptoms	5.6 (5.3)	5.5 (3.7)
Total	46.7 (43.2)	27.5 (18.6)
Locomotor disorders		
– Hoof injuries	2.1 (1.9)	7.3 (5.0)
– Overhrown hooves	–	0.9 (0.6)
– Lameness	5.1 (4.7)	9.2 (6.2)
– Leg weakness	1.0 (0.9)	1.8 (1.2)
Total	8.2 (7.5)	19.2 (13.0)
Small litter size	21.0 (19.4)	18.3 (12.4)
Mastitis	– (7.5)	(32.3)
Inadequate mothering behaviour	3.1 (2.8)	0.9 (0.6)
Old age	7.2 (6.7)	11.9 (8.1)
Death	4.6 (4.3)	6.4 (4.3)
Thin	–	2.8 (1.9)
Inappetence	0.5 (0.5)	2.8 (1.9)
Miscellaneous	8.7 (8.1)	10.1 (6.8)
Total	100 (100)	100 (100)

The calculations were performed with sows culled due to mastitis either excluded, or included.
The results of the latter calculations (mastitis sows included), are given in brackets.

related to subsequent litter size (*Kirkwood et al.* 1988, *Hughes* 1993). These observations are not in agreement with our results since previous investigations in the herds used in the present study showed that feed consumption was lower among the C-farm sows than among the G-farm sows (*Hultén et al.* 1997). Moreover, feed consumption seemed to be highest among the older (≥ 5th parity) G-farm sows, as indicated by the fact that they, in contrast to the younger sows, gained backfat during lactation (*Hultén et al.* 1997). Although indications suggesting a positive relationship between food intake during lactation and subsequent litter size have been reported by some investigators, others have not found any such relationship (*Prime et al.* 1988). Moreover, in both groups litter size among older sows was quite comparable to previous reports (*Esbenshade et al.* 1986, *Gatel et al.* 1987, *Neil & Ogle* 1996). The large size of the litters produced by older C-farm sows suggests that management routines, such as the feeding programme and routines for mowing/grouping, were well designed for these sows.

In both housing systems, the percentage of primiparous sows mated within 10 days post weaning exceeded corresponding values reported in many earlier studies on individually housed sows (*Einarsson & Settergren* 1974, *King* 1978, *Sterning et al.* 1990), but resembled values obtained when oestrous detection was performed carefully in the presence of a boar

(*Sterning et al.* 1994). In the present study all sows were kept in groups in the breeding section, whereby sows in oestrus could stimulate the onset of oestrus among the other sows (*Pearce & Pearce* 1992). Moreover, previous studies in the herds used in the present study showed that backfat loss among primiparous sows was quite moderate during lactation (*Hultén et al.* 1997). It is well known that low weight and backfat loss are related to a short weaning-to-breeding interval (*Reese et al.* 1984, *Sterning et al.* 1990). In addition, boars were used to detect oestrus, which also stimulates the onset of oestrus (*Pearce & Pearce* 1992). Among multiparous sows the percentage mated within 10 days post weaning was significantly lower in the G-farm group than in the C-farm group. This difference could be attributed to the fact that a large proportion of the older (≥ 5th parity) group-housed sows show oestrus during lactation, whereby the subsequent breeding period is prolonged (*Hultén et al.* 1995a). The positive relationship between parity number and occurrence of lactational oestrus previously noted (*Hultén et al.* 1995a) was also evident in this study where most of the sows mated during lactation were older (≥ 5th parity), and none was primiparous. The fact that subsequent litter size among primiparous G-farm sows was larger if the sows were mated later than 10 days post weaning agrees with previous studies (*Love* 1979). Furthermore, this result could indicate that some of these sows were mated on their second oestrus after weaning (*Sterning & Lundeheim* 1995). Among the multiparous sows there was no difference in subsequent litter size between those mated within 10 days post weaning and those mated afterwards. Thus, the fact that litter size was smaller among the older (≥ 5th parity) G-farm sows than among the older C-farm sows could not be explained by the low percentage of older G-farm sows mated within 10 days post weaning. Within the C-farm group, the percentage of sows mated within 10 days post weaning seemed to have been unaffected by season. By contrast, among the older (≥ 5th parity) G-farm sows a seasonal pattern was evident, with a low proportion of sows being mated within 10 days after weaning during the winter months. Previous studies indicate that lactational oestrus in group-housed sows is most likely to occur during January and February (*Petchey & Jolly* 1979), and the occurrence of lactational oestrus prolongs the subsequent breeding period (*Hultén et al.* 1995a). Thus, in agreement with previous studies, the low frequency of older sows mated within 10 days post weaning from December to February could indicate that oestrus during lactation occurs frequently during these months. The seasonal pattern was more evident among the older (≥ 5th parity) G-farm sows than among the 2nd-4th parity G-farm sows, probably because ovulations during lactation occur mainly among these older sows (*Hultén et al.* 1995a). The low frequency of G-farm sows mated within 10 days during September agrees with previous reports showing that ovulations during lactation also occur in the autumn (*Hultén et al.* 1995a).

In the present study the weaning-to-mating interval was longer among primiparous sows than multiparous ones, which agrees with many previous studies (e.g. *Kirkwood et al.* 1988). The similar weaning-to-mating interval among primiparous sows in the 2 housing systems indicates that in this respect no adverse effect of grouping during lactation occurred.

The more scattered distribution of the sows mated within 10 days post weaning in the G-farm group compared with in the C-farm group is probably related to the occurrence of lactational oestrus and to the fact that group housing during late lactation stimulates pituitary/ovarian activity in some sows (*Duggan et al.* 1982). Although the percentage of primiparous sows mated within 10 days post weaning was high in both groups, a large proportion of these sows returned to oestrus. In a study where sows were penned in pairs during the breeding period and group housed during the gestation period farrowing rates among second-parity sows were between 87.8% and 91.2%, indicating that the repeat-breeder frequency was lower than in the present study (*Love* 1979). However others have reported farrowing or pregnancy rates among second-parity sows within a range that indicates that repeat-breeder frequencies were similar to those in the present study (*Morrow et al.* 1989, *Sterning & Lundeheim* 1995). The high repeat-breeder frequency among primiparous sows grouped during the breeding and gestation period could partly be attributed to stress. When placed in groups, young sows are more likely to suffer severe stress since rank is positively related to age, and having a low-rank position is more stressful. (*Arnone & Dantzer* 1980, *Sambraus* 1981, *Hunter et al.* 1988, *Tsuma et al.* 1996). Moreover, group housing during early pregnancy seems to increase the occurrence of repeat breeders (*Bokma* 1990).

Among the multiparous C-farm sows, the repeat-breeder frequency was quite low, whereas among the multiparous G-farm sows repeat breeding was as common as among the primiparous sows. The prolonged breeding period in the G-farm group, caused by the occurrence of oestrus during lactation, might have made the routines for oestrous detection and artificial insemination less efficient. The fact that the sole use of artificial insemination had been more common among sows returning to oestrus compared with those that did not do so supports this conclusion. The larger proportion of the repeat-breeder sows in the G-farm group returning to oestrus 2 or more times before being successfully bred, compared with the repeat breeders in the C-farm group, is a further indication that routines for oestrous detection and mating/insemination in the G-farm group were inadequate. In addition, in one of the G-farms, sows were moved to the gestation section 3 weeks after weaning, suggesting that many sows were moved in early pregnancy which is considered to have negative effects on embryo survival (*Einarsson et al.* 1996). The high frequency of repeat breeders among the older (≥ 5th parity) G-farm sows cannot explain why litter size was smaller among these sows than among older C-farm sows, as litter size among repeat breeder sows and among those that did not return to oestrus was the same. The high frequency of repeat breeders in the G-farm group from December to March could indicate that lactational ovulations occurred frequently during this period, and as a result, oestrous detection and the timing of mating/insemination after weaning were impaired. In both groups the highest frequency of repeat breeders seemed to occur from July to September. It is well known that seasonal infertility, manifested, for example, by an increased number of sows showing a delay in their return to oestrus and a reduced farrowing rate, tends to occur during summer and autumn (*Love et al.* 1993). The occurrence of seasonal infertility is more evident among group-housed sows than among sows kept stalled, and generous feeding during early pregnancy seems to decrease its manifestation (*Love et al.* 1995). All sows in the present study were restrictively fed and group-housed during the breeding and gestation period, which could explain why seasonal infertility occurred in this study.

Although the annual removal rate was higher in the C-farm group than in the G-farm group, removal rates for both groups were within the range previously reported (*Einarsson & Settergren* 1974, *Stein et al.* 1990, *D'Allaire & Drolet* 1992). Excluding the C-farm sows culled due to mastitis the removal rates were quite similar in the 2 groups. Any comparisons between groups in terms of reasons for culling should be made with care since bias could be expected, caused by the high culling rate for mastitis in the C-farm group. Mastitis mainly seemed to affect younger sows, as indicated by the finding that in the present study the mean parity in sows culled due to mastitis was lower than the overall mean for the 2 groups This observation is further supported by previous reports showing that primiparous sows suffer more frequently from acute mastitis compared with other age groups (*Hultén et al.* 1995b) and that cullings due to mastitis are most common among 2nd-parity sows (*Svendsen et al.* 1975). In the G-farm group, reproductive failure was the reason for culling in almost half of the culled sows, which is within the upper range of what has previously been reported (*Einarsson & Settergren* 1974, *Svendsen et al.* 1975, *Stein et al.* 1990, *D'Allaire & Drolet* 1992). Repeat breeding/failure to farrow was the most common reproductive failure, further indicating that these disturbances are of major concern in the group-housing system. Few sows in the G-farm group were culled owing to locomotor disorders. This could partly be an effect of the high frequency of reproductive failures, but might also indicate that group housing during lactation has a beneficial effect on leg soundness. However, both groups were within the frequency range previously reported for locomotor disturbances in conventional housing systems (*Stein et al.* 1990, *D'Allaire & Drolet* 1992). Inadequate mothering behaviour seemed to be a more common reason for culling among group-housed sows which indicates that good mothering behaviour is of great importance in the group-housing system.

Conclusions

It can be concluded that use of the group-housing system impairs productivity, as indicated by the smaller litter size among older (≥ 5th parity) sows, compared with older conventionally housed sows, the lower proportion of sows mated within 10 days post partum, the higher repeat-breeder frequency and the larger proportion of sows culled due to reproductive failure. These effects are probably related in part to the occurrence of lactational oestrus, which makes it difficult to maintain adequate routines for oestrous detection and mating/insemination.

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Sammanfattning

En studie av reproduktionsresultatet i ett grupphållningssystem för digivande suggor.

Reproduktionsresultatet utvärderades i fyra besättningar som grupperade suggorna från två veckor efter grisningen till avvänjningen (G-gruppen) samt i tre besättningar (kontroller) som inhyste suggorna enskilt under hela diperioden (K-gruppen). Samtliga suggor var svensk yorkshire×svensk lantras och diperioden var 5-6 veckor lång. Suggorna grupperades i betäcknings- och i dräktighetsavdelningen. I samtliga besättningar grisade suggorna omgångsvis och varje omgång bestod av 8-22 suggor. Under 16 månader insamlades reproduktionsdata genom regelbundna gårdsbesök.

Bland de äldre (≥ 5 grisningar) suggorna var kullstorleken signifikant ($p = 0.02$) mindre i G-gruppen än i K-gruppen, medan det ej förelåg någon skillnad bland de yngre suggorna. Andelen suggor som betäcktes inom 10 dagar efter avvänjningen var lägre ($p<0.001$) i G-gruppen än i K-gruppen. Denna skillnad var mest påtaglig bland de äldre suggorna. Bland förstagrisarna var omlöpningsfrekvensen ungefär lika i båda inhysningssystemen, medan en signifikant ($p = 0.04$) större andel av de äldre suggorna i G-gruppen löpte om jämfört med de äldre suggorna i K-gruppen. I båda grupperna verkade omlöpningsfrekvensen vara högst under perioden Juli-September. Omlöpning/utebliven grisning var en vanlig slaktorsak i G-gruppen. Resultaten indikerar att reproduktionsresultatet är sämre i gruppsystemet. Orsaken kan delvis vara förekomst av brunst under diperioden vilket försämrar möjligheterna att upprätthålla optimala betäcknings/inseminationsrutiner.

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