REARING PIGS IN SPECIES-SPECIFIC FAMILY GROUPS

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Abstract *Animal Welfare 1996, 5:* 25-35

In the Family Pen System piglets and fatteners grow up in species-specific family groups that correspond to the normal social organization of domestic pigs. The feasibility of a technologically improved version of this alternative housing system, originally designed by Alex Stolba, was tested on a commercial farm for two and a half years. Eighty-one litters were born in three family groups within this period. Average cycle length was 170 ± 24 (SD) days, resulting in 2.15 litters per sow per year. All piglets were suckled for at least seven weeks. In 53.8 per cent of the cycles lactational oestrus occurred before the piglets were seven-weeks-old. The litters of sows which did not show lactational oestrus were artificially weaned and returned to the family group as soon as the sow had been served. At the beginning there were problems with piglet health and crushing, but in the last 21 months of the study there was a stable reproductive performance of 19.5 piglets (28-days-old) reared per sow per year (n = 53 litters). Sows that had been raised themselves in the Family Pen System reared 21.4 piglets per year (n = 25 litters). In conclusion, the technologically improved version of the Family Pen System was found to be practicable on a commercial farm.

Keywords: *animal welfare, lactational oestrus, pen design, pig housing*

Introduction

The social behaviour of domestic pigs kept in semi-natural enclosures is very similar to the behaviour of wild boars (Stolba & Wood-Gush 1984, 1989; Jensen 1986, 1989). During pregnancy the sows live in stable groups. For farrowing they leave the group and build a nest in a sheltered site away from the group's main activity area. About 10 days after farrowing the sow and her litter return to the group. Natural weaning is a gradual process that finishes when the piglets are about 12 to 17-weeks-old (Stolba 1986; Jensen & Recén 1989). After weaning the young pigs remain with the group of their mother sow.

The rearing conditions of pigs kept in conventional housing systems contrast very much with this natural situation. Each sow and her litter are usually kept in an individual pen for the whole suckling period. At the age of three to five weeks the piglets are separated from the sow and thereafter reared in groups in which all pen mates are of approximately the same age. These standard housing conditions are likely to impair the welfare of the growing pigs. Artificial weaning is known to result in a short-term increase in behavioural indicators of stress (Dybkjær 1992). There may also be long-term effects on welfare if the pigs do not grow up in species-specific family groups; that is in groups consisting of several sows and their litters which is the typical social system of the ancestor of the domestic pig, the wild boar.

In the early eighties Alex Stolba developed a combined housing system for breeding sows and fattening pigs, the Family Pen System (Stolba 1981, 1986; Stolba & Wood-Gush 1984). In this housing system four sows and their litters are kept in species-specific family groups in an enriched pen built in an open-fronted building. Three weeks after farrowing a boar is added to the family group. He serves the sows during lactation and the growing pigs are naturally weaned when they are about 12-weeks-old. After weaning the fatteners remain within their family group until they are sold as porkers (> 65kg) or baconers (> 85kg). They reach these weight classes 10 days before the next litters are born.

A first version of the Family Pen System was tested from 1982 to 1985 at the University of Edinburgh and from 1983 to 1988 at the University of Zürich (Stolba & Wood-Gush 1984; Stolba 1986; Kerr *et al* 1988; Wechsler *et al* 1991). The reproductive performance of the sows was found to be very good. They were served early in lactation and produced 2.4 litters per year. There were, however, three major problems with this version of the Family Pen System. First, piglet mortality was much higher than in conventional housing systems. Second, it was time consuming to separate the sows for feeding in different areas of the family pen and to distribute the food with buckets. Third, the pigs often defaecated in the straw-bedded activity area and removal of the manure required too much time.

In the present study a technologically improved version of the Family Pen System was tested on a commercial farm near Zürich. In order to reduce piglet mortality, the nest areas were structured in a new way. A heated piglet nest was positioned at the border of the nest site of the sow. All feeding troughs were made accessible from passageways and feeding stalls were installed to separate the sows. An outside yard was added to the inside pen to offer the pigs an attractive dunging area away from the nest and the activity areas. The manure in the outside yard was removed mechanically. As fatteners are commonly reared up to a weight of 100kg in Switzerland, a solution was found to keep groups of fatteners within the housing system but apart from the sows and their next litters. It was the aim of the study to compare this new version of the Family Pen System with conventional housing systems, with regard to productivity and management aspects.

Methods

At the beginning of the study, three pregnant sows (Swiss Landrace), nine pregnant gilts (two Large White, seven Swiss Landrace) and a boar (Large White) were bought from a commercial breeder. The housing background of these animals was not known. They were distributed to three family groups each made up of one sow and three gilts. The intervals between the farrowing dates of these groups were six weeks whereas all sows and gilts in a family group farrowed within nine days. With this herd structure it is possible to serve all sows with a single boar that is transferred from group to group in intervals of about six weeks.

The study lasted from June 1991 to December 1993. In this period family group size was increased from four to five sows to raise the number of fatteners on the farm. Thirteen sows were replaced: five sows had an insufficient reproductive performance, two had leg problems, two died (twisting of the guts) and four Swiss Landrace sows were replaced by Large White sows to increase the portion of the latter breed in the herd. In the course of the study 5 more gilts (one Swiss Landrace, four Large White) were bought from commercial breeders and 10 gilts were reared within the Family Pen System. In order to prevent

inbreeding, the boar was replaced in October 1992. All together, there were 81 litters of 27 sows. Average herd size was 14 sows, 50 piglets (up to 10-weeks-old), 72 fatteners and one boar.

Each family group was kept in a family pen (Figure 1). The three pens were built side by side in an open-fronted building. The pens were divided into a sheltered part within the stable (12x10m) and an outside yard (12x2.5m). The inside pens were structured by visual barriers (1.1m high). In each pen there were four nest areas in the rear of the stable and two activity areas. The pens had a sloped (2%) concrete floor. In the nest areas the floor was covered with straw. The amount of straw was varied with the season. In 1993 a total of 10,000kg of straw was used for the three family groups (ie 0.2kg per pig per day).

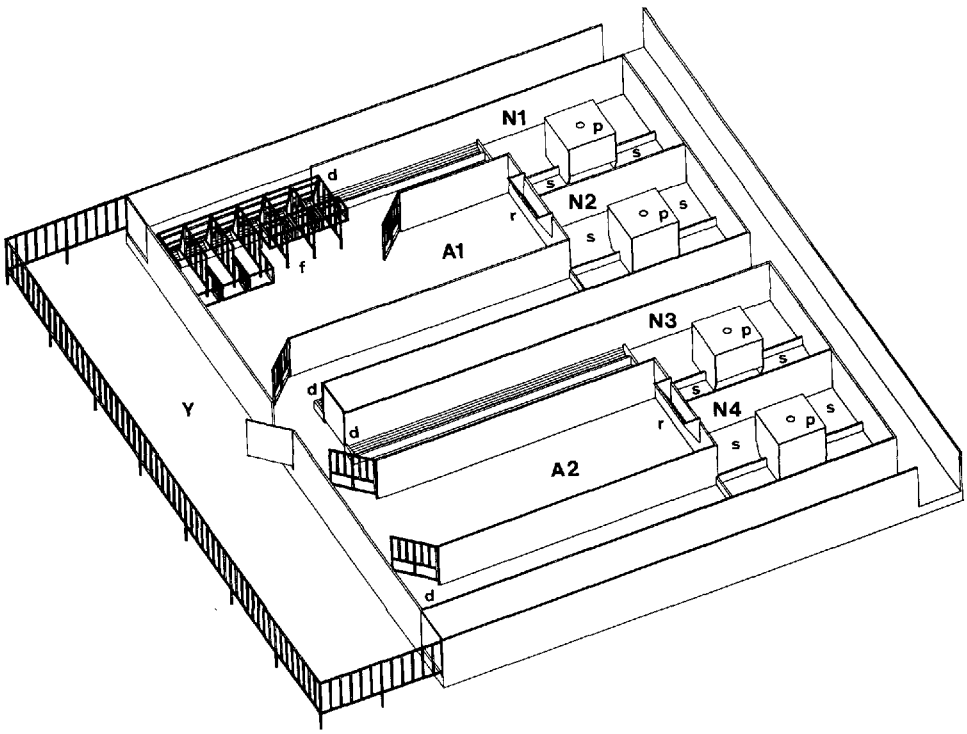

Figure 1 **View into a family pen with four nest areas (N1 to N4), two activity areas (A1, A2) and an unsheltered outside yard (Y). The pen includes six feeding stalls (f), four sites with drinkers (d), four piglet nests (p) and two racks (r). For farrowing only half of the floor of the nest areas was covered with straw (s).**

Six days a week manure was pushed manually from the indoor pens to the outside yards from where it was removed with a tractor. From June 1992 to March 1993 the distribution of faeces in a family pen was recorded on 193 occasions. This was done by dividing both the inside pens and the outside yards into sectors of about 1.2m^2 and estimating the percentage of the surface covered with faeces in each sector.

https://doi.org/10.1017/S0962728600018303 Published online by Cambridge University Press

The sows, the boar and the fattening pigs (older than 10 weeks) were fed twice a day with liquid food. On average (n = 186 days) this was composed of 9.3 per cent barley, 3.5 per cent protein concentrate, 35.5 per cent kitchen refuse, 27.3 per cent whey and 24.4 per cent added water. The sows and the boar were fed in individual stalls whereas the fatteners were fed in troughs along the corridors leading away from the nest areas. At the end of each corridor there were nipple drinkers. After morning feeding, the racks in the activity areas were filled with straw, hay or grass for behavioural enrichment. In addition, some compost-earth was distributed by the tractor in the outside yards after removal of the manure.

A few days before farrowing the family pen was power-hosed. Thereafter the sows were separated in the nest areas by closing the doors at the end of the corridors. When five sows farrowed at the same time, one sow was separated in a nest area of a neighbouring family pen. In the first version of the Family Pen System (Stolba & Wood-Gush 1984) the heating lamp for the piglets was situated at the border of the nest area and behind rails. The problem with this design was that for the first two to three days after the birth the piglets did not lie under the lamp but close to the sow's body (Wechsler *et al* 1991). In the technologically improved version of the Family Pen System the nest areas were therefore structured according to the farrowing pen designed by Schmid (1993). The piglet nest with a heating lamp and a heating plate on the floor was placed in the centre of the nest area, next to the nest site of the sow (Figure 1). With this design the piglets found the heated place within the first day of life. In order to ensure that the sow chose her nest site next to the opening of the piglet nest, only half of the floor of the nest area was covered with straw. During the study all sows built their nest in this part of the nest area. From June 1991 to July 1993 piglets that died in the Family Pen System were brought to the Department of Veterinary Pathology at the University of Zürich to determine if they had been crushed by the sow.

On an average of 14 ± 3 (SD) days after the last sow of a family group had farrowed, the inside pen was divided into two parts of equal size. The four to five sows and their litters were then grouped in the left half of their family pen (with feeding stalls). They were offered a communal nest by removing the partition between the two neighbouring nest areas (N1 and N2, Figure 1). The piglet nests were pushed to the border of this area and a special piglet area was installed in the corridor next to the feeding stalls. In this area the piglets had *ad libitum* access to solid food until they were 10-weeks-old. On an average of 8 ± 7 (SD) days after the formation of the family group, the boar was added to serve the sows during lactation.

As the piglets grew up, space was increased by also giving the family group access to the right half of their family pen with a second activity area and two more nest areas (N3 and N4, Figure 1). The fatteners remained with the sows until they were five-months-old. Then the fatteners had to be removed because the sows were going to farrow again. The fatteners were kept for an additional four to eight weeks in the right half of a family pen, the left half being occupied by a family group which had recently been grouped after farrowing. When the fatteners reached a weight of 100kg, they were brought in groups of 6 to 10 to the slaughter-house.

All fatteners were sold to a marketing organization ('Porco fidelio') specialized in distributing meat of pigs reared in enriched housing systems. Preventative admixing of antibiotics to the food as well as teeth clipping and tail docking in piglets were prohibited. The organization also required that the piglets were suckled for at least seven weeks. The

price of fatteners reared in this way is about 20 per cent higher than the price of conventionally reared pigs.

Statistical analysis

Non-parametric statistics (Mann-Whitney *U* tests, Spearman rank correlations; Siegel 1956) were used because not all data were normally distributed. If not indicated otherwise, *P*-values are two-tailed. In the agricultural literature, data on the reproductive performance of sows are usually presented as mean values. Therefore, mean values and standard deviations (SD) are used in the text and in the tables.

Results

A total of 878 piglets were born alive in the three family groups within two and a half years. Data on reproductive performance of the sows were calculated separately for three time periods (A, B, C) of 10 to 11 months each (Table 1). This was done to illustrate the development of the reproductive performance of the sows during the course of the study. As the study was started mainly with gilts, parity (the number of litters born per sow) increased significantly from period A to period B and from B to C ($P < 0.05$, Mann-Whitney *U* tests). There were, however, no significant differences in litter size between the three periods ($P > 0.05$, *U* tests). On average (n = 81 litters) 10.8 ± 2.6 (SD) piglets were born alive, and 4.6 per cent of all piglets were born dead.

Table 1 **Reproductive performance of sows in the Family Pen System (period A: June 1991 to March 1992, period B: April 1992 to February 1993, period C: March 1993 to December 1993; average values are given with standard deviations).**

Performance	Period		
	A	B	C
Number of litters	28	27	26
Number of piglets born alive	283	302	293
Average parity	1.9±1.2	2.5±1.2	3.4±1.6
Piglets born alive per litter	10.1±2.7	11.2±2.4	11.3±2.7
Piglets born dead per litter	0.5±0.7	0.4±0.6	0.6±1.0
Piglet mortality (%)[1]			
- overall mortality up to day 28	30.1	19.5	18.4
- crushed up to day 28	20.5	13.8	9.2
- dead between day 29 and day 70	5.6	3.3	1.7
Litter size at day 28	7.1±2.8	9.0±2.7	9.2±2.6
Litter size at day 70	6.6±2.9	8.6±2.6	9.0±2.6
Fatteners sold per litter	6.5±2.9	8.5±2.5	8.9±2.6
Mean conception day	54±9	53±25	56±28
Cycle length (days)	170±9	168±26	172±28
Number of litters per year	2.15	2.17	2.12
Number of piglets (day 28) per sow per year	15.4	19.5	19.5

[1] Percentage of piglets born alive

https://doi.org/10.1017/S0962728600018303 Published online by Cambridge University Press

There were major problems with piglet health (oedema disease, scour) and with crushing at the beginning of the study. From period A to period B, however, both overall piglet mortality up to day 28 and the percentage of piglets crushed decreased significantly ($P < 0.05$, U tests). Consequently, there was a significant increase in average litter size from period A to period B (day 28: $P < 0.01$, day 70: $P < 0.01$, fatteners sold: $P < 0.01$, U tests). Between periods B and C neither piglet mortality nor litter size differed significantly. Mortality in fatteners was stable over the three periods and amounted to 1.1 per cent of the piglets that had reached the age of 10 weeks.

On average the sows were successfully mated on day 55 ± 24 (SD) after farrowing (n = 54). Mean cycle length was 170 ± 24 (SD) days, resulting in 2.15 litters per sow per year. Both in period B and in period C 19.5 piglets were reared per sow per year. With eight litters (three in period A, two in B and three in C) there was a delayed start in the milk production of the sow, and 72.5 per cent of the piglets born alive in these litters died before they were four-weeks-old. When these litters were omitted from the analysis, overall mortality up to day 28 dropped to 13.3 per cent and crushing to 8.6 per cent in periods B and C combined (n = 48 litters). In this sample 9.7 ± 1.8 (SD) piglets per litter were reared up to day 28, resulting in a production of 20.8 piglets per sow per year.

The rearing success of sows of different breeds did not differ significantly. The analysis included all litters from periods B and C in which the sows had no problem with milk production (n = 48). Both Large White sows (n = 14 litters) and Swiss Landrace sows (n = 23 litters) reared on average 9.7 ± 1.7 (SD) piglets per litter up to day 28. The remaining 11 litters were of Large White x Swiss Landrace crossbred sows that had been born in the Family Pen System. They had an average litter size of 9.6 ± 2.4 (SD) piglets on day 28.

Sows that had been raised in the Family Pen System produced 21.4 piglets per year in periods B and C whereas sows that had been bought from commercial breeders reared 20.1 piglets per year (Table 2). The number of piglets born alive as well as average cycle length did not differ between these two samples. But overall piglet mortality up to day 28 was significantly lower in litters of sows raised in the Family Pen System ($P < 0.05$, U test, one-tailed). There was also a tendency that these sows crushed fewer piglets ($P < 0.07$, U test, one-tailed). Average parity was significantly lower in sows raised in the Family Pen System ($P < 0.001$, U test). Parity was, however, not significantly correlated with overall piglet mortality ($r_s = 0.23$, n = 48, $P > 0.05$) nor with the percentage of piglets crushed ($r_s = 0.11$, n = 48, $P > 0.05$). The five litters with a delayed start in the milk production of the sow in periods B and C were not included in Table 2, but it has to be mentioned that they were all from sows that had been bought from commercial breeders.

Piglet mortality was not significantly affected by season. In 17 litters born in summer (May to August) in periods B and C, overall piglet mortality up to day 28 was 16.3 per cent compared with 13.0 per cent in 16 litters born in winter (November to February). Litters with a delayed start in the milk production of the sow were not included in this analysis, and litters from sows that had been raised in the Family Pen System were equally distributed between the two samples (eight litters in summer and seven litters in winter).

Table 2 **Comparison of the reproductive performance of sows bought from commercial breeders and sows raised in the Family Pen System (average values are given with standard deviations).**

Performance	Origin of the sows	
	Commercial breeders	Family Pen System
Number of litters	23	25
Average parity	3.7±1.3	2.0±1.0
Piglets born alive per litter	11.1±2.4	11.1±2.7
Piglet mortality (%)[1]		
- average mortality up to day 28	17.2	9.5
- crushed up to day 28	11.5	5.8
Litter size at day 28	9.4±1.8	9.9±1.9
Cycle length (days)	171±31	169±22
Number of litters per year	2.14	2.16
Number of piglets (day 28) per sow per year	20.1	21.4

[1] Percentage of piglets born alive

In 28 out of 52 cases (53.8%) the sows were successfully served during the first seven weeks of lactation. If there was no lactational oestrus in this period (n = 24 cases), the sow was separated from her litter for a few days and kept in another family pen together with the boar. As soon as the sow had been served she was returned to the family group. This artificial weaning was necessary to keep a stable interval of about six weeks between the farrowing dates of the three family groups. There were 17 cases in which pregnant gilts or sows had been bought from commercial breeders, 10 cases in which gilts were raised in the Family Pen System and two cases in which oestrus was induced by a hormone injection.

On average, sows served during lactation conceived on day 44 ± 18 (SD) and had a cycle length of 159 ± 19 (SD) days (2.3 litters per year), whereas sows served after artificial weaning conceived on day 67 ± 25 (SD) and had a cycle length of 183 ± 25 (SD) days (2.0 litters per year). There was no significant difference in the number of piglets born per litter depending on whether the sows had been served in lactational oestrus or after weaning. Sows that conceived during lactation regularly suckled their piglets until these were 12-weeks-old. At 14 weeks most litters were not suckled any more, but one litter was only weaned when the piglets were 18-weeks-old.

In most cases either all sows of a family group or none were served during lactation, and farrowing dates were well synchronized in the group (within two weeks). Only on six occasions a sow had to be transferred to another family group, as her farrowing date was more than three weeks later than the dates of the other sows in her group. These group changes were inevitable, because cross-suckling of the piglets can become a major problem if age varies too much between litters. The introduction of a sow into another family group did not result in excessive aggressive behaviour, as the family pens were well structured. This enabled the new sow to withdraw from the other group members after some initial fights.

Gilts were selected from the fattener groups. The selection was based on the growth and the physique of the gilt as well as on the reproductive performance of her mother. Nine out

of ten gilts were reintroduced to the family group in which they had been reared. This was done when the sows and their litters were grouped two weeks after farrowing. Although the gilts had been separated from their family group for 31 to 69 days, the sows and the gilts obviously recognized each other, as there were no fights. The gilts were then served for the first time (on average 203 ± 21 (SD) days old) together with the sows of their family group.

The fattening period started when the pigs were 70-days-old (weight about 25kg) and ended when they were about 170-days-old (weight 100kg). In two groups of fatteners (n = 40 and 26 animals) from two different family groups, average daily weight gains of 751g and 803g, respectively, were computed for this period. A total of 264 fatteners per year were produced in the three family groups.

In the first 12 litters (four in each family group) at the beginning of the study, suckling behaviour was observed in detail. All piglets were marked individually and the presence of cross-sucklers was recorded in a total of 1866 nursing bouts from week two to week eight after farrowing. Only 10 out of 89 piglets (11.2%) gave up the teat on their mother's udder and, after a few days, suckled with another sow. Interestingly, all these piglets changed to the sow with the least number of piglets in her family group.

For 16 days, time required to prepare and distribute the food (twice a day) as well as to remove the manure from the three family pens was measured. On average, labour input was 18min day^{-1} for preparing the soup, 23min day^{-1} for feeding the sows and the growing pigs, 28min day^{-1} for cleaning the inside pens and 9min day^{-1} for removing the manure from the outside yards with a tractor. As can be seen in Figure 2, the pigs defaecated mainly in the outside yards and, to a lesser extent, in the activity areas of the inside pens.

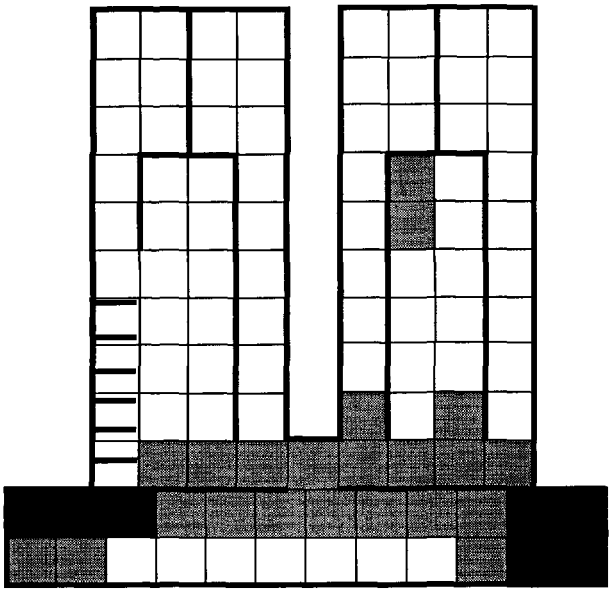

Figure 2 **Distribution of faeces in the family pen. The shadings indicate the average percentage of each sector's surface that was covered with faeces (white: 0 to 10%, light grey: 11 to 50%, dark grey: 51 to 100%).**

Discussion

In the second and third period of the study the sows had a stable performance of 19.5 piglets (28-days-old) reared per year in the new version of the Family Pen System. For a comparison, Large White and Swiss Landrace sows kept in conventional housing systems rear on average 21.5 and 20.7 piglets per year, respectively (data published by the union of breeders in Switzerland, Kleinviehzucht 1993). The fact that the sows that had been raised in the Family Pen System reared on average 21.7 piglets per year shows that the reproductive performance of the sows can reach the level of conventional housing systems.

Although all piglets were suckled for at least seven weeks, mean cycle length was only 170 days. This is just one week longer than average cycle length in sows of Swiss breeds whose litters are usually weaned at the age of four to five weeks (Large White: 163 days, Swiss Landrace: 164 days; Kleinviehzucht 1993). The combination of a long suckling period and a relatively short cycle length was possible because 53.8 per cent of the sows were served within the first seven weeks of lactation. The incidence of lactational oestrus was, however, lower than in the original version of the Family Pen System where 81.9 per cent of the sows were served during the first seven weeks of lactation (Kerr *et al* 1988). In the present study the sows conceived also later in lactation (on average on day 44) than in the original version of the Family Pen System (day 33, Kerr *et al* 1988). The difference in the occurrence of lactational oestrus is possibly due to the poorer quality of the food given to the sows. On the commercial farm a ration containing 35 per cent kitchen refuse of variable energy content was used whereas in the study of Kerr *et al* (1988) the sows were fed with pellets.

In order to reduce piglet mortality the nest areas were structured in a new way for farrowing. In the first period of the study overall mortality up to day 70 was extraordinarily high (35.7%), dropping to 22.8 per cent and 20.1 per cent in the second and third period, respectively. These percentages are very similar to the mortality in the original version of the Family Pen System where 21.9 per cent of all piglets born alive died within the first 10 weeks (Kerr *et al* 1988). Especially for crushing (13.8% and 9.2% in the second and third period of the study, respectively) better results had been expected, as the nest areas were structured in the same way as the farrowing pen designed by Schmid (1993) in which only 5.5 per cent of the piglets were crushed.

Piglet mortality was significantly lower in sows that had been raised in the Family Pen System compared to sows that had been bought from commercial breeders, and the former sows also tended to crush fewer piglets (only 5.8 %). Their good performance can, however, not merely be attributed to the housing conditions during their ontogeny, as daughters of sows with low rates in mortality and crushing were, of course, preferentially selected as replacement gilts. It is also possible that the home-bred sows were better adapted to the disease profile present on the farm and that they passed their immunity to the piglets. Nevertheless, the results indicate that the productivity of the Family Pen System can be improved by creating a breeding stock that is (probably both genetically and ontogenetically) adapted to these housing conditions.

The management of pigs kept in family groups is much different from the management of tethered sows or fatteners kept in small groups. But there is also a routine that is repeated in each reproductive cycle of a family group and it caused no organizational problems to run three family groups in parallel on the commercial farm. Artificial weaning after seven weeks

without lactational oestrus was found to be a practicable solution to achieve a constant interval of about six weeks between the farrowing dates of the three family groups. In addition, it was sometimes necessary to transfer a sow to another family group, if she had conceived more than three weeks later than the rest of the sows of her group. Both types of intervention are not optimal with respect to the pigs' welfare, but in some cases inevitable for a continuous production of fatteners.

It was an aim of the present study to improve the original version of the Family Pen System with regard to time required to feed the pigs. Kerr *et al* (1988) described an advanced version of the Family Pen System with individual sow feeding stalls and *ad libitum* feed hoppers for the growing pigs. They measured a mean of 14.3min day^{-1} required to feed all pigs of one family group. In the present study there were also feeding stalls for the sows, but the growing pigs were fed twice a day with liquid food. Time required to feed all pigs of one family group was, however, almost identical (13.9min day^{-1}).

Time required for daily cleaning of the family pens is reduced if the pigs concentrate their eliminative behaviour to dunging sites that are situated in the front of the stable. With the technologically improved version described here, this was achieved by adding outside yards to the indoor pens. In a previous study Mollet and Wechsler (1991) had found that pigs have a preference for dunging sites in which they can have contact with conspecifics in a neighbouring pen. The gates between the outside yards of the three family pens were therefore filled with lattice. As expected, the sectors close to these gates turned out to be very attractive dunging sites.

Animal welfare implications

The study has shown that the Family Pen System is practicable on a commercial farm and that it is feasible to rear piglets and fatteners in species-specific family groups. Artificial weaning is not necessary at all with half of the litters, as the sows can be served in lactational oestrus. With the other half of the litters artificial weaning can be delayed until the piglets are seven-weeks-old and their separation from the sow has to last but a few days. In addition, it is possible to keep the sows in groups of closely related animals by integrating gilts into the family group in which they were reared.

In the technologically improved version of the Family Pen System, pigs are kept in a complex and enriched environment. The family pens are well structured and divided into several areas. Within these areas the pigs find different environmental qualities that elicit different types of behaviour. When moving around the pen, they meet variably composed subgroups of their family group. These features contrast much with the standard rearing conditions of piglets and fatteners kept in small groups and in largely unstructured pens. In conclusion, the Family Pen System not only enables the pigs to live in species-specific family groups, but also offers them a physical environment of high quality.

Acknowledgements

I am grateful to the Federal Veterinary Office of Switzerland, the Kanton Zürich, the 'Zürcher Tierschutz' (a local animal welfare organization) and the Messerli-Stiftung (Luzern) for their financial support of the research project (No 014.90.4). I also thank Josef Gisler who was running the Family Pen System on the farm. He helped to collect data, together with Iris Bachmann, Nadja Brodmann and Daniel Hegglin. I thank Titus Sydler and Esther Bürgi for analysing the pathologists' reports.

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