

The influence of sequential and simultaneous feeding and the availability of straw on the behaviour of gilts in group housing

M. KRAUSE¹, C.E. VAN 'T KLOOSTER^{1,*}, R.G. BURÉ , J.H.M. METZ¹ AND H.H. SAMBRAUS²

¹ DLO-Institute for Agricultural and Environmental Engineering (IMAG-DLO), P.O.Box 43, NL-6700 AA Wageningen, the Netherlands

² Department of Animal Husbandry and Applied Animal Behaviour, Technical University of Munich, 80350 Freising-Weihenstephan, Germany

* Corresponding author (fax: +31-317-425670; e-mail: c.e.vantklooster@imag.dlo.nl)

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Abstract

Effects of two feeding systems and the unlimited availability of straw in a rack on behaviour of gilts in group housing were studied in an experiment with 240 gilts. In three replications four treatments were compared; electronic feeding station for sequential feeding of sows having access to straw in a separate feeding rack (ESF with straw) or not (ESF without straw) and electronically controlled simultaneous feeding in boxes and with straw available (FB with straw) or no straw in the feeding rack (FB without straw). The animals were active for 13.7, 13.5, 17.1 and 13.9% of their time in respectively ESF with straw, ESF without straw, FB with straw and FB without straw, the interaction between feeding system and availability of straw being significant ($P < 0.01$). Animals visited the feeding system 6, 6, 13 and 15 times per day for respectively ESF with straw, ESF without straw, FB with straw and FB without straw. Synchronization of eating straw was higher in the FB system while the engagement with the concentrate feeder was higher in the ESF system. There were more injuries on the hindquarters of sows in the ESF treatments, whereas the availability of straw had no effect. It is concluded the sequential feeding of group housed juvenile pigs with an ESF caused serious behavioural problems among the animals.

Keywords: group housing, feeding, sows

Introduction

Individual housing systems for sows are widely used as a system where individual feed intake can be controlled. Efforts are made to improve the welfare of dry and pregnant sows by developing group housing systems where individual control of feed intake is possible (Den Hartog *et al.*, 1993; Morris *et al.*, 1993) and sows are in groups through almost the entire reproduction cycle (Houwens *et al.*, 1996). Considering restricted feeding, until recently individual control of feed intake in group housed sows was only possible with an electronic sow feeding station (ESF).

In ESF systems sows are given a ration based on the individual feed allowance after being telemetrically identified by means of a transponder attached to the ear of the sow. In the ESF the feeding of concentrates is in sequential order. In systems with sequential intake of concentrates, behaviour of pigs with undesired consequences for their welfare has been observed. An example is the agonistic behaviour near the entrance of the ESF, including vulva biting (Edwards *et al.*, 1988; Van Putten, 1988; Buré, 1988). So far vulva biting has only been reported in ESF systems.

Feeding systems for group housed sows with computer controlled individual and simultaneous feeding have been introduced recently as an alternative to ESF systems (Hoofs, 1990; Morris *et al.*, 1993). These systems lock sows in individual feed boxes (FB) during feeding and combine the technical possibilities of individual feed distribution and registration of ESF systems with the synchronized feeding pattern of pigs (Csermely & Wood-Gush, 1986; Hsia, 1981; Hsia & Wood-Gush, 1984).

The energy requirements of sows can be met with 2 to 3 kg concentrates per day, but it leaves the animals with an eating motivation that remains unsatisfied (Lawrence *et al.*, 1988). The availability of a roughage like straw contributes to an improvement of animal welfare according to several authors (Fraser, 1975; Etienne, 1987; Lee & Close, 1987).

An experiment was conducted to compare the sequential feeding (ESF) and simultaneous feeding with individual identification (FB) for young sows kept in group housing by means of assessment and analysis of the behaviour of the animals. A second objective was to evaluate to what extent the unrestricted availability of straw in a rack influenced behaviour in both systems.

Materials and methods

Animals and facilities

A total of 240 crossbred gilts (GY.(GY.NL)) averaging 110 kg in weight with an age of 6 months of age at the beginning of the experiment were used. This young age avoided that animals in heat had a strong influence on the results. The 20 gilts were introduced in five batches of four animals from the rearing house into the experimental group. The rearing phase was carried out under standardized circumstances to obtain gilts with similar social experiences in their juvenile phase. Pigs were reared in groups, where regular regrouping of animals was practiced. This training included groups with initial weights of 23 kg where in a dry feeder with water nipple feed was continuously available and ended in groups preceding the experimental periods where pigs were fed with an ESF feeder (Houwens, 1994). The groups were dynamic; every 4 weeks subgroups of about 6 animals who had been in this group for the longest period of time were removed, while a subgroup of six animals from the preceding age group was added.

The housing system was divided in two areas: An indoor area with the lying areas and the ESF and an outdoor area where the FB and the straw rack were installed (Figure 1). Both areas were provided with a bare solid concrete floor. The outdoor

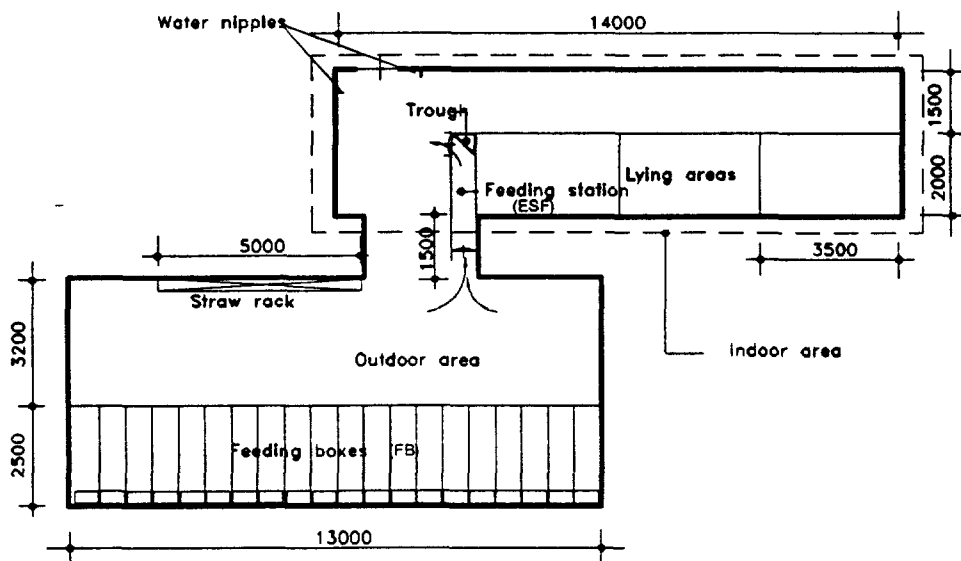


Figure 1. Layout of the housing system.

area had a roof to protect the animals from rain, snow and sun. Both the ESF system (Nedap-Poiesz) and the FB system, (Woldrix-feeding boxes) were commercially available types. Both systems used electronic individual identification of animals. Gilts carried responders attached to their ears. The animals were fed twice a day, starting at 07.00 h and at 15.00 h each portion being 1 kg pelleted concentrates (8.54 MJ NE/kg) at a dispensing rate of 1.4 g/s in the ESF or of 4.4 g/s in the FB system. In both systems left-overs could be consumed by the next sow visiting, but this occurred seldomly.

The straw rack was mounted on a side of the outdoor area and filled with unchopped wheat straw.

Treatments

The treatment runs were carried out in a sequential order: ESF with straw, ESF without straw, FB with straw and FB without straw. Each run lasted four weeks. This sequence was repeated three times.

In the first two weeks of each run, animals could habituate to the system (Krause, 1995).

Behavioural measurements

Activity, feeding behaviour, agonistic behaviour and the synchronization of activities around the afternoon feeding time were quantified.

Activity was measured in terms of the percentage of active versus non-active ani-

mals. Non active animals were lying and showed no other activities. Active animals were standing, walking, sitting or even lying, but in that case actively employed with equipment or the feeder, eating straw, or occupied with other lying animals. An animal was called employed with the feeder when she was either sniffing, nibbling or biting parts of the feeder, while her head could be somewhat turned.

Feeding behaviour was split into eating straw and paying rewarded or unrewarded visits to the concentrate feeder. Eating straw was defined as pulling straw from the rack and showing chewing movements (head upwards and moving mouth) in the immediate vicinity of the rack. A visit to the concentrate feeder meant that the animal was inside the feeding system and electronically identified. It was called a rewarded visit when concentrates were supplied.

Agonistic behaviour was analyzed according to Jensen (1980). The direction of the interaction was determined as towards head, towards middle or towards rear when the head of the attacker aims at the head region of the attacked animal, the middle parts of the body of the attacked animal or the hindquarters of the attacked animal.

Synchronization of behaviour was analyzed for the eating of straw and for the employment with the feeder. The term synchronized behaviour was used when at either place two or more animals were employed with the behavioural category.

Behaviour of the animals was recorded with three video cameras. The lying area was not observed. In both the third and the fourth week of an experimental period a 24 hour period was recorded by video. These recordings were continuous in order to record agonistic interactions. To determine total activity and synchronization of behaviour these 24-hour recordings were split in 10 minutes intervals. The behaviour of all gilts was analyzed during all intervals. The 24-hour recordings were split and analyzed in 2 minutes intervals in the period from 14.30 h till 17.00 h to obtain more detailed data for defined behaviours involved in the afternoon feeding. On two more days video recordings were made from 14.30 h till 17.00 h and analyzed in 2 minutes intervals. Data on social rank were obtained both at the start of the experiment during 12 hour continuous observations on the first three days of an experimental period and from the agonistic behaviour of the video recordings during the last two weeks (Krause, 1995). Animals were allotted to three categories; high, middle and low ranking animals. Animals were allotted to the high ranking group when with at least half of the potential opponents the number of wins exceeded the number of losses by at least 3. Animals were allotted to the low ranking group when with at least half of the potential opponents the number of losses exceeded the wins by at least 3. All other animals were allotted to the middle ranking group.

The computer software of both feeding systems recorded time and duration of all visits of animals to the feeding place over 24 hour periods during all weeks. The visits were divided in visits with and without feed dispensed.

Body injuries

The body injuries (inflammations, skin abrasions and open wounds) within the head, middle or rear region of the gilts were scored as described by Krause (1995) at the

start of the experiment, one week later and after 4 weeks and were classified as none, some (one or two injuries) or many (three or more injuries in the body region).

Statistical analysis

The behavioural data and data on body injuries were analyzed using generalized linear mixed models (Engel & Keen, 1994) of the statistical package Genstat 5 (Anonymous, 1993). Independent variables used in the analyses were: Feeding system, availability of straw, location, ranking order position, number of experimental repetition and week of observation (per experiment). Two-way interactions were included in the analysis, but three-way interactions were excluded, as the interpretation is very difficult. So they were included in the stochastic part of the model.

Agonistic behaviour was not statistically analyzed, as too few data on gilts per observation day were available. Averages per experimental treatment and per group in ranking order are presented.

Results

Total activity

Over 24 hour periods the percentage of active gilts in the experimental treatment 'FB with straw available' was significantly higher ($P < 0.01$) than in the other treatments, on average 17.1%. It was 13.9% in the FB without straw and 13.7 and 13.5% respectively in the treatments ESF with and without straw. The interaction between feeding system and availability of straw was significant ($P < 0.01$).

The diurnal activity pattern in the ESF with and without straw is given in Figure 2. There is a strong resemblance between both diurnal patterns. After a slow and steady rise in activity from 6.00 h, activity peaks in both treatments around the second feeding start at 15.00 h. Around 01.00 h a period of almost total inactivity begins.

Figure 3 shows the diurnal activity pattern in the FB situation with and without straw. In both treatments two activity peaks are seen that correspond with the feeding times. The only difference between both graphs is that after the first meal the activity level in the system with straw was higher than in the system without straw. In both treatments a period of total inactivity started at 23.00 h and lasted till 05.00h.

Feeding behaviour

The gilts in the systems with feeding boxes visited the feeding boxes on average 13 times per day when straw was available and 15 times per day when no straw was available (Table 1). This is approximately twice as often as gilts in the systems with the electronic sow feeder, where animals visited the ESF significantly less frequent, on average 6 times per day, regardless of the availability of straw ($P < 0.001$). Within treatments differences between the ranking groups were not statistically significant ($P > 0.05$).

The diurnal pattern in visits to the ESF systems with and without straw is given in

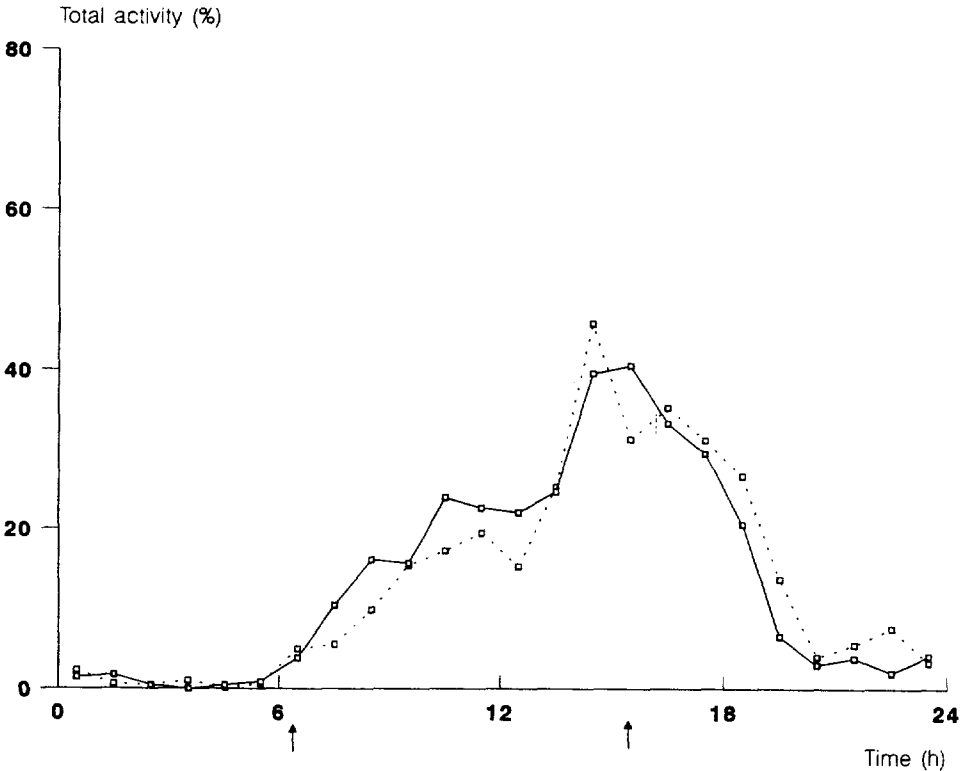


Figure 2. Diurnal activity expressed as percentage of animals being active in the system with the electronic sow feeder (ESF) and with and without straw supply (— = ESF with straw, = ESF without straw, ↑ = feedstart).

Figure 4. A peak in the number of visits per hour was reached just before the second feeding started. From 01.00 h onwards the feeding station was hardly visited. In the systems with feeding boxes the number of visits showed peaks at both feeding times (Figure 5). When no straw was available with the feeding boxes, the number of visits reached higher peaks compared to the system with straw.

Table 1. Total number of daily visits to the feeding system per gilt in each ranking category (ESF = group housing with Electronic Sow Feeder, FB = group housing with individual ration in feeding boxes).

	n	ESF		FB	
		straw	no straw	straw	no straw
Animals					
High ranking	59	7	8	16	22
Middle ranking	120	6	5	9	12
Low ranking	54	5	5	14	12
Total	233	6	6	12	15

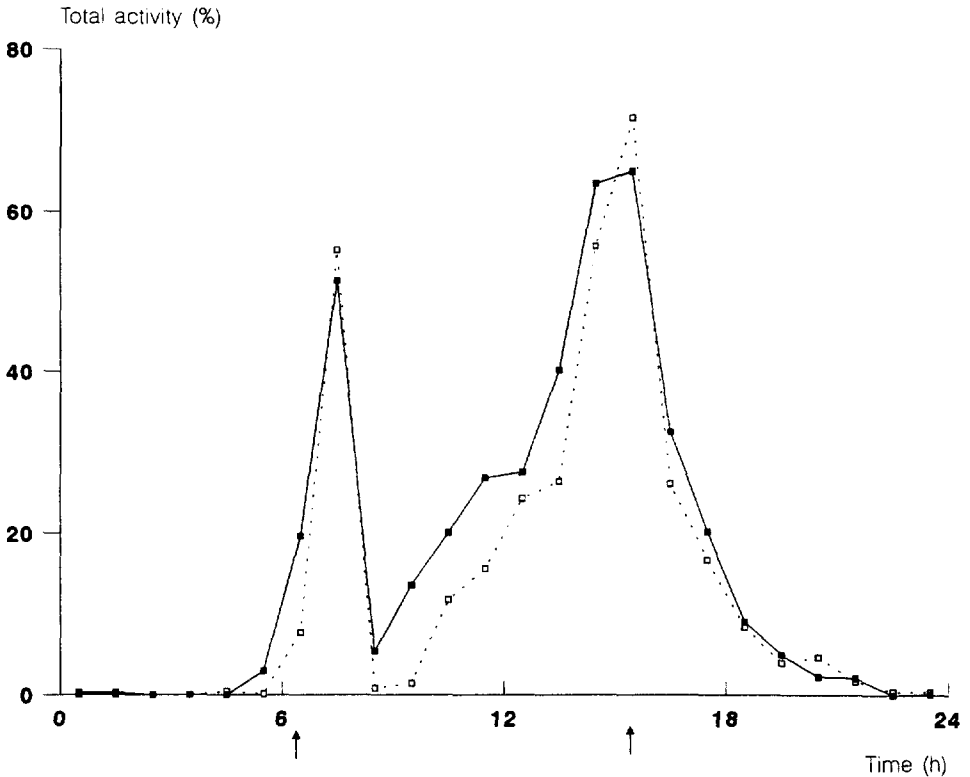


Figure 3. Diurnal activity expressed as percentage of animals being active in the system with the feeding boxes (FB) and with and without straw supply (— = FB with straw, = FB without straw, ↑ = feedstart).

Synchronization of behaviour

Synchronized eating of straw at the rack was seen in the FB systems (132 observations) approximately twice as frequent as in the ESF systems (64 observations) ($P < 0.001$). Synchronized eating of straw was observed more frequently in the system with feeding boxes as compared to the ESF system (Figure 6). In both systems synchronized eating of straw was only observed in small groups with 7 or less sows.

In the treatments with ESF much more ($P < 0.001$) synchronized employment with the feeding system (106 times per day with straw and 116 times per day without straw, respectively) could be seen than in the systems with feeding boxes (8 and 18 times a day with and without straw, respectively).

Sows were less employed with the feeding equipment when straw was available ($P < 0.001$). In none of the systems the animals showed a high degree of synchronized employment with the feeding system (Figure 7), but in the ESF system levels were higher than in the FB system.

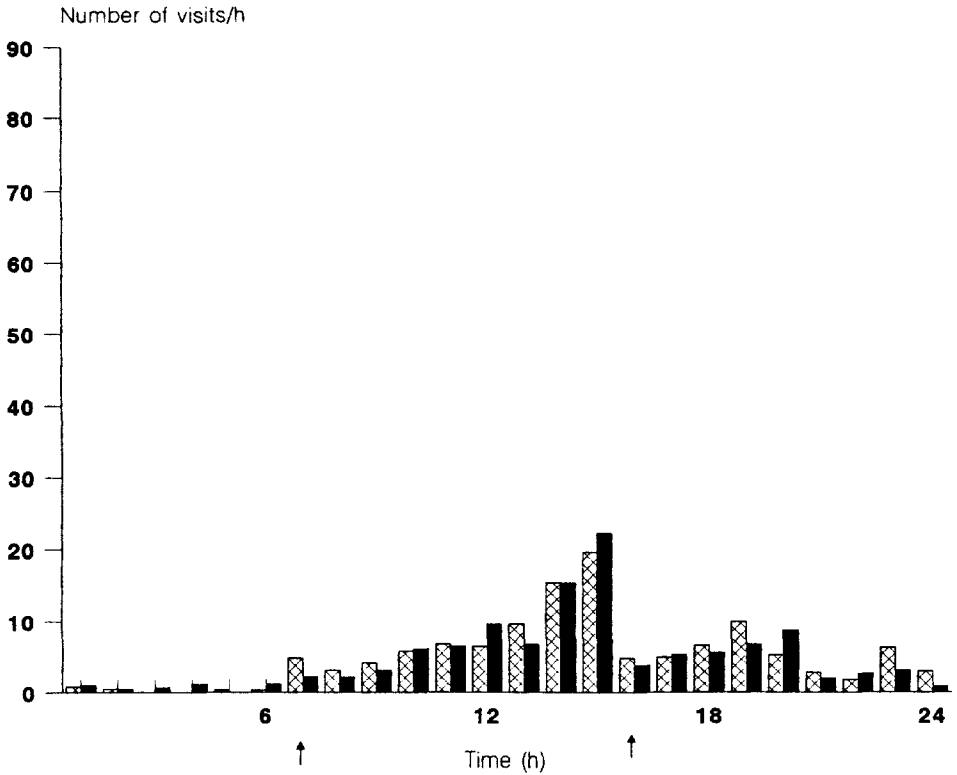


Figure 4. Diurnal fluctuations in the number of visits to the feeder of gilts fed with the electronic sow feeding station (ESF) with and without straw (□ = ESF with straw, ■ = ESF without straw, ↑ = feedstart).

Agonistic behaviour and injuries

The number of agonistic interactions between gilts in the ESF system were 5.8 and 7.4 total agonistic actions per gilt with and without straw available, respectively and in the FB system 4.0 and 3.0 with and without straw, respectively. The observed agonistic interactions divided over the ranking groups are given in Table 2.

Table 2. Total number of observed agonistic actions per gilt in each ranking category during 6 x 24 hours (ESF = group housing with Electronic Sow Feeder. FB = group housing with individual ration in feeding boxes).

	n	ESF		FB	
		straw	no straw	straw	no straw
Animals					
High ranking	59	9.2	13.4	7.9	4.6
Middle ranking	120	5.6	5.0	2.7	3.0
Low ranking	54	3.1	4.8	3.6	1.4
Total	233	5.9	7.1	4.2	3.0

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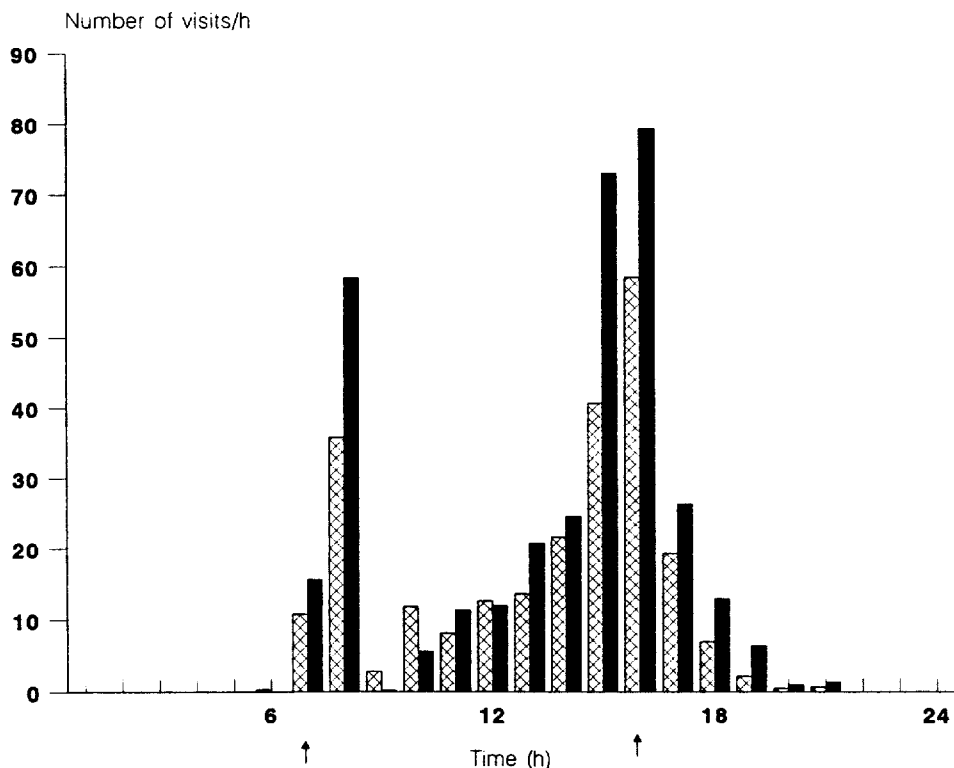


Figure 5. Diurnal fluctuations in the number of visits to the feeder of gilts fed in feeding boxes (FB) with and without straw (□ = FB with straw, ■ = FB without straw, ↑ = feeding).

The locations where interactions between gilts were observed are given in Table 3. Whenever straw was available, a high number of interactions was observed at the straw rack. The average number of agonistic interactions between gilts housed in the FB system is almost twice as high as for the sows housed in the ESF system. In the treatments without straw hardly any agonistic interactions were observed near the

Table 3. Total number of observed agonistic actions per gilt and location in the pen during 6 x 24 hours (ESF = group housing with Electronic Sow Feeder, FB = group housing with individual ration in feeding boxes).

Areas	ESF		FB	
	straw	no straw	straw	no straw
Side of ESF	0.4	0.4	0.1	0.4
Straw rack	1.3	0.5	2.5	0.6
Entrance of ESF	2.6	4.8	0.2	0.7
Entrance of FB	0.4	0.3	0.2	0.7
Exit of ESF	0.4	0.7	0.1	0.1
Drinking nipple	0.6	0.8	0.9	0.6

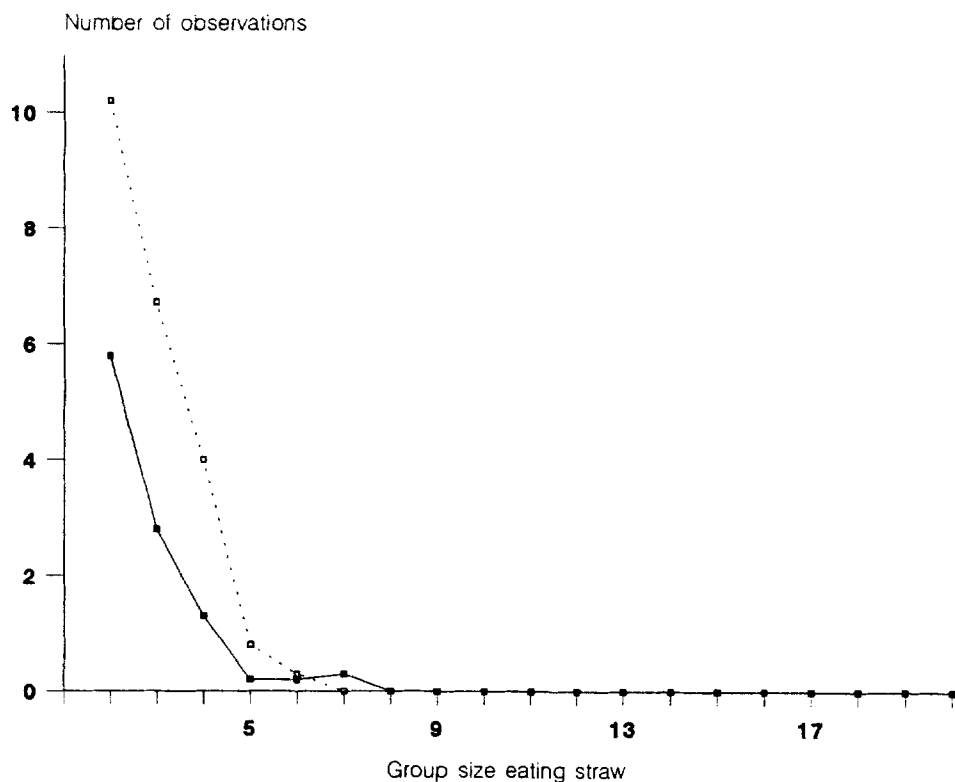


Figure 6. Number of observations of synchronic eating of straw at the rack as a function of the number of gilts involved in synchronic eating of straw (— = ESF with straw, = FB with straw).

straw rack. The gilts with the feeding station had a high number of agonistic interactions at the entrance of the feeding station. When no straw was available this number was even higher. Gilts in the feeding boxes had hardly any confrontations at the entrances of the feeding boxes. Around the water supply and at the side of the feeding systems few confrontations were seen.

The confrontations were mostly directed towards the head of the receiving animals (Table 4). Frequency of confrontations directed to the head of the receiving animals was highest at the entrance of the electronic sow feeding station. Also most of the interactions directed towards the side and rear of receiving animals took place at the ESF entrance. At the exit of the ESF some confrontations towards the rear was observed. At the straw rack and at the entrances to the feeding boxes virtually all observed confrontations were directed to the head. Around the water nipple confrontations were also mainly directed to the head. Agonistic actions directed towards the rear of the gilts were exclusively observed in the ESF-situation and the supply of straw decreased these numbers but did not eliminate such actions (Table 5). The injuries in the hindquarters of gilts are given in Table 6. The feeding system had a pronounced effect with more injuries in the ESF housing ($P < 0.001$), whereas the availability of straw had no effect ($P > 0.05$).

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Table 4. Total number of observed agonistic actions depending on zone and direction of attack (ESF = group housing with Electronic Sow Feeder, FB = group housing with individual ration in feeding boxes).

Areas	Direction		
	Head	Side	Rear
Side of ESF	64	5	0
Straw rack	282	2	0
Entrance of ESF	311	67	106
Entrance of FB	93	2	1
Exit of ESF	65	1	10
Drinking nipple	177	0	1

Discussion

In literature on group housing of sows with sequential individual feeding animal activity, defined as not lying, is observed during 15 to 30 % of the total time (Barnett

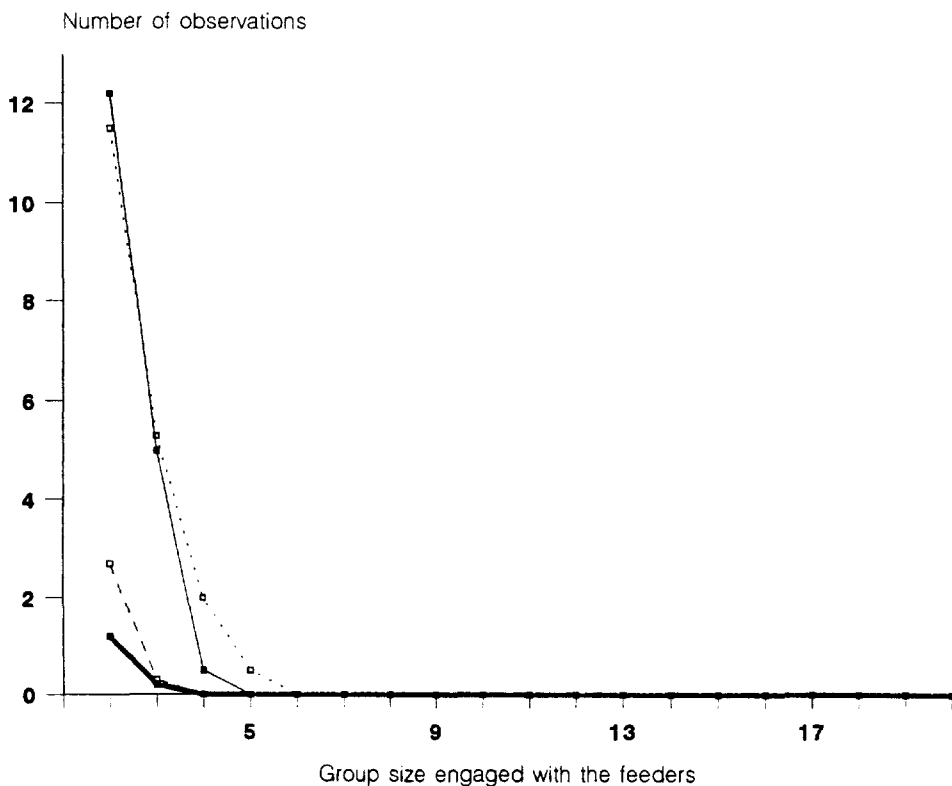


Figure 7. Number of observations of synchronized employment with the feeding system in function of the size of the group employed with the feeding system (— = ESF with straw, = ESF without straw, — = FB with straw, ---- = FB without straw).

Table 5. Total number of observed agonistic actions depending on treatment and direction of attack (ESF = group housing with Electronic Sow Feeder, FB = group housing with individual ration in feeding boxes).

Place of attack	ESF		FB	
	straw	no straw	straw	no straw
Head	278	299	236	179
Side	24	48	3	2
Rear	35	83	0	0

et al., 1985; Olsson *et al.*, 1986; Ritter, 1988; Ernst *et al.*, 1990; Lehmann, 1991; Taureg *et al.*, 1991; De Baey-Ernsten, 1993). Results of this study were within this range. Marx & Buchholz (1989) found that supply of straw increased activity. This study showed that only with the combination of feeding boxes and supply of straw an increased activity was observed. The interaction between feeding system and supply of straw is therefore important.

The simultaneous and sequential feeding systems had different influences (single phase versus biphasal) on the activity pattern of gilts. The availability of straw did not have a visible impact on the activity levels. These findings for gilts contrast with findings of Marx & Buchholz (1989) and Marx *et al.* (1989), who found an increase in activity levels when piglets were provided with straw. It can be observed from the results that with the ESF also some activity is measured during nocturnal hours, although pigs are primarily day-active animals (Gundlach, 1968). If animals are not allowed to be fed simultaneously, some animals seem to cope with this situation by consuming their feed at a less favoured moment and with a low risk of agonistic interactions.

In experiments of Lehmann (1991) sows paid daily on average 51 visits to a feeding box but only 3.7 visits daily to an ESF. In this study the number of visits was also strongly influenced by the feeding system with more visits to feeding boxes than to the ESF. Visits to the FB were in this experiment less frequent than in Lehmann's experiment, possibly because the housing and environment in this experiment was fairly complex and provided several distractions for sows. The supply of straw had no clear influence on the number of visits to the feeding systems.

Ritter (1988) found that high ranking sows visited the ESF more frequently than

Table 6. Number of injuries in the hindquarters region (ESF = group housing with Electronic Sow Feeder, FB = group housing with individual ration in feeding boxes).

	ESF with straw		ESF without straw		FB with straw		FB without straw	
	some	many	some	many	some	many	some	many
At start	17	0	7	1	23	3	13	4
After 1 week	24	7	20	2	10	2	10	3
After 4 weeks	14	6	13	3	1	0	2	0

low ranking animals. Lehmann (1991) found that high ranking sows paid more unrewarded visits to the ESF than low ranking sows. The results of this study, where low ranking animals were hardly hindered in their access to the ESF, do not show an effect of rank order on the total number of visits to the ESF.

The diurnal activity pattern strongly corresponds with the pattern of visits to the feeding systems. De Baey-Ernstén (1993) also concluded that visits of sows to feeding stations have a strong correlation with the activity pattern. Results in this paper also support the conclusion that the feeding system is the most important factor in the activity pattern of gilts housed in groups. The activity in the ESF system was spread over a long period, creating some nocturnal activity.

Pigs that were observed under semi-natural conditions showed synchronised feeding behaviour (Hsia, 1981; Hsia & Wood-Gush, 1984; Gonyou *et al.*, 1992). Whereas space at the straw rack in this study was sufficient for all gilts, group size at the straw rack never exceeded 6 or 7 gilts for both feeding systems. The lower incidence of synchronic eating of straw in the ESF system is likely caused by the sequential eating of concentrates.

The findings in the ESF system that sows wait in groups before the feeding station, confirm results reported by Brade *et al.* (1986) and Rantzer *et al.* (1988). The results support the idea that the behavioural activity is synchronized and group based, supported by environmental cues. Furthermore it can be noted that the availability of straw reduced the number of visits to the feeding systems but did not reduce the number of animals waiting in front of the feeding system.

The effect of supply of straw in both feeding systems was completely different. At the straw rack several confrontations were observed. For sows straw as a feed is worth defending against congeners (Ewbank & Bryant, 1972; Schnebel & Griswold, 1983) and as such the supply of straw will be accompanied by some agonistic interactions between animals, although straw was available continuously in unrestricted amounts.

Van Putten (1988) and Weber *et al.* (1993) related an increase in agonistic behaviour in the waiting area of a feeding station to the situation where sows have to queue. The problem of increased agonistic behaviour around a feeding station can not be overcome but merely be reduced by the supply of straw. No more agonistic behaviour was observed in the waiting area as compared to the rest of the allotted space. When no straw was supplied a potential source of agonistic behaviour of gilts was eliminated, resulting in a totally lower incidence of agonistic interactions between gilts.

Most of the agonistic actions were directed towards the head, including biting. The results confirm findings of McGlone (1985). However, especially near the entry and the exit of the feeding station also agonistic actions directed towards the rear of animals were observed. Van Putten (1988) mentions a high incidence of vulva biting in ESF systems. In behavioural studies of wild pigs (Beuerle, 1975) and pigs housed in groups and fed in boxes (Jensen, 1980) vulva biting is not reported. The association between vulva biting and ESF systems is also confirmed by own observations, where agonistic actions directed towards the rear of animals were not found in the system with feeding boxes. A high occurrence of agonistic behaviour directed towards the

rear of animals was found in the ESF system without supply of straw. Buré (1988) concluded that an insufficient amount of feed supply combined with unrewarded visits to the feeding station is the cause of vulva biting and he suggests to supply additional feed outside the feeding station. Van Putten and Van De Burgwal (1990) reported from a preliminary experiment a reduced incidence of vulva biting once additional maize silage was provided twice a day outside the feeding station.

Our own observations show that this effect can also be achieved by feeding unlimited amounts of straw in a rack. The ESF concept is tested here in a particular layout. Apart from feeding strategies to reduce the incidence of vulva biting, the particular lay-out of an ESF system, e.g. increase the time, distance and/or provision of stimuli between exit and entrance of ESF system may also reduce this incidence. Further experiments with ESF systems would be required to explore this potential.

However, for a complete elimination of the agonistic interactions directed towards the rear of animals a switch from sequential to simultaneous feeding seems recommendable as these agonistic actions were never observed in the system with feeding boxes.

Conclusions

The observed differences in behaviour were associated with the way of feeding of the pigs: simultaneously or in a sequential order. The ESF system resulted in more injuries on the hindquarters. Using an ESF for feeding of female pigs thus caused serious problems among the animals.

Gilts waited in groups in front of the ESF, in the ESF system some gilts were active at night, usually a period of rest.

By using a system for simultaneous feeding (FB) most of the negative effects with respect to injuries could be avoided or they were less.

A decline of injuries on the hindquarters of gilts after the start of the experimental period was seen in systems with simultaneous feeding.

Furthermore it is concluded that supply of straw – in the way it had been offered in this trial – had only a limited effect on behaviour in an ESF system. It reduced but did not eliminate the incidence of attacks on the rear parts of other pigs. That means that although the use of straw can be sensible either to occupy gilts or for some consumption, straw alone may not solve the problems with the sequential feeding method.

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