A STUDY OF SPATIAL BEHAVIOUR OF PREGNANT SOWS HOUSED IN PENS WITH VARIOUS FEEDING AND DUNG DISPOSAL SYSTEMS

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Ninety-six pregnant sows, previously penned in individual stalls, were housed in groups of four in pens containing three zones: a) four individual feeding stalls without rear gates, b) a communal sleeping kennel and c) a dunging area between the stalls and kennel. The feeding stalls were either long (2m) or short (1m) with barriers made of wire mesh. The daily allowance of 2.5kg pelleted feed per sow was presented either all at once (dump) or at the rate of approximately 100g/min by a manual system (trickle). Dung disposal systems were either a pit filled with sawdust-based compost, a slatted floor, or straw on a sloped concrete floor. There were two replicates of the 2x2x3 factorial design. The location of sows was observed from time-lapse video recordings taken at regular intervals throughout the 31 day experimental period.

Use of the three zones of the pens was influenced by feeding method, barrier length and dung disposal system. Overall the feeding stalls were used more with trickle than with dump feeding ($P<0.05$); more with long than with short barriers ($P<0.001$), and most with slatted floors and least with the straw system ($P<0.001$). All these treatments had the opposite effects on the use of the communal kennel. The use of the dunging area was not affected by feeding method or stall length but was greater ($P<0.01$) on the compost compared with the other two dung disposal systems. Throughout the experimental period the use of feeding stalls decreased ($P<0.001$). Circadian use of the pen zones interacted with barrier length and dung disposal system. Kennels were used most at night in pens with straw, exceeding 54min/h with half length (1m) stalls. The lowest night-time use of kennels, around 8min/h, was found in pens with full length (2m) stalls combined with either compost or slats. Ambient temperature did not have a major influence on use of pen zones.

The occupation of stalls, especially full length stalls, indicates that offering a choice between solitary and communal areas may improve the welfare of group-housed sows.

Keywords: *animal welfare, behaviour, pen design, sows*

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Introduction

Sows are naturally social, with feral animals living together in small groups and sleeping in communal nests (Graves 1984; Jensen 1988). Sows in these groups are often closely related (Kerr *et al* 1988) unlike commercial farm groups whose composition may be determined solely by synchronization of weaning or conception. Small groups of farmed sows living together throughout gestation show a wide variation in the degree of aggression associated with social instability (Edwards 1992). Individual animals may seek isolation from the group, even temporarily, as seen when sows are newly mixed (van Putten & van de Burgwal 1990).

The present experiment was set up to investigate how sows used space when offered continuous voluntary access to a communal kennel, individual feeding stalls and various types of dung disposal system together with the effect of method of feed presentation. The overall objective was to examine aspects of alternative systems for housing dry sows particularly in situations where straw availability is limited.

Materials and methods

The experiment used 96 multiparous cross-bred sows in a factorial design (2x2x3) over time. The factors were feeding system, stall length and dung disposal system. The daily feed allowance was offered either all at once (dump) or at the rate of 100g/min (trickle). The stalls had no rear gates and were either 2m long (full length) or 1m long (half length). The dung disposal systems had either sawdust-based compost, slatted floor or solid floor with straw.

In the parity prior to the experiment, sows had been housed individually in stalls and farrowing crates. During the experiment sows were housed in groups of four in pens 2.4x7m. Four feeding stalls, each 0.6m wide with barriers 1m high manufactured from square mesh steel at 0.2m centres, were situated at one end of each pen. A communal roofed sleeping kennel 2.4x2m was provided at the other end of the pen leaving a dunging area of 2.4x3m between the stalls and the kennel. The slatted pens had concrete slats 125mm wide with 25mm gaps between slats. The compost was based on sawdust plus broiler house litter in an insulated pit 0.8m deep with the top 0.1m of compost dug once a week by hand to promote aerobic fermentation without added enzymes. In both the slatted and compost systems bedding was not provided in the kennels. In the third system straw was provided on solid concrete floors with a six per cent slope from kennel to feeders (Bruce 1990). About 1kg straw per sow was added daily at the top of the slope inside the sleeping kennel and, by subjective estimate, approximately one third was soiled and removed daily from the dunging area together with dung and urine. Most of the remaining straw appeared to be eaten since there was no accumulation in the kennels. In all treatments the floors were insulated in the feeding and kennel areas. The kennel fronts were provided with strip curtains made of heavy-duty polythene. Nipple drinkers were sited in the dunging areas. Two replicates of each of the twelve pen types, ie 24 pens in all, were allocated at random within a portal frame uninsulated building with concrete block walls and a corrugated steel roof.

The sows were all from landrace and large white parentage and in mid pregnancy of the second or later parity. Once daily each sow was offered 2.5kg of a pelleted diet based on barley, wheat feed, soya bean and fish meals with calculated nutrient contents (per kg air dry matter) of 13.4MJ digestible energy, 8.6g total lysine and 172g crude protein. On the dump

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feeding system the four sows in each group were fed simultaneously. With trickle feeding, feed was transferred manually into each feeding stall at the rate of approximately 100g per minute. Feeding started at 0830h each day.

Each group of sows was on experiment for 31 days and their behaviour was observed on days 1, 2, 3, 10, 17, 24 and 31 for 24h. Day 1 was the day of transfer to the experimental housing. Behaviour was recorded using time-lapse video recordings at two frames per second with infrared lighting. Additional lighting was supplied from 0730h to 1600h. Sows were identifiable individually by numbers painted on their backs.

The use of space was measured by sampling video recordings at 10 minute intervals. On each occasion the locations of sows were identified (feeding stalls, dunging or kennel areas) together with their posture (standing or lying). The field of view of the video camera did not extend inside the kennel and the posture of sows in this location was unknown. The temperature and moisture content of the compost were measured weekly at four locations. The maximum and minimum air temperatures in the house were measured each day outside the kennels 1.2m above floor level.

The proportion of sows for each location and posture was calculated and subjected to analysis of variance (Genstat 5, Lawes Agricultural Trust, Rothamsted Experimental Station, UK). A split-split-plot model was used with the 24 groups of four sows (ie two feeding methods x two barrier lengths x three dunging systems x two replicates) as the main plots, the seven observation days for each group as the sub-plots and the 24 hourly observations as the sub-sub-plots.

Results

It was assumed that sampling the location of sows every 10 minutes would give a measure closely related to the proportion of time spent in the three zones of the pen. Overall, sows spent the highest proportion of time in the feeding stalls (0.51), least time in the dunging area (0.13) and an intermediate time in the kennels (0.36). The effects of treatments (Table 1) showed that sows spent significantly more time in feeding stalls with trickle feeding ($P<0.05$), with full length barriers ($P<0.001$) and with the slatted floor dung disposal system ($P<0.001$) and spent least time in stalls with the straw system ($P<0.001$). Sows spent more time in kennels with dump feeding ($P<0.001$), with half length barriers ($P<0.001$) and with the straw system ($P<0.001$). Feeding method and barrier length had no effect on time spent in the dunging area but this was increased with the compost disposal system ($P<0.01$). There were no significant interactions between feeding and dung disposal system treatments.

Behaviour in feeding and dunging zones was classified into standing or lying. There were no significant effects of treatments on proportion of time spent standing in the feeders (0.12 overall). In contrast, time spent lying in the feeding stalls was significantly affected by method of feeding, barrier length and dung disposal system. Dump feeding decreased the time spent lying in the feeders compared with trickle feeding (0.30 and 0.47 respectively, $P<0.01$, SEM [standard error of the mean] = 0.034). Full length barriers increased time spent lying in feeders compared with half length barriers (0.50 and 0.26 respectively, $P<0.001$, SEM = 0.034). Sows spent most time lying in the feeders with the slatted floor dung disposal system, an intermediate time with the compost system and least time when straw was available (0.59, 0.37 and 0.19 respectively, $P<0.001$, SEM = 0.042).

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Table 1 **Treatment effects on the mean proportions of sows using various zones of the pen over the whole experimental period.**

Pen zone	Feeding method		Barrier length (m)		Dung disposal system			SEM	
	Dump	Trickle	2	1	Compost	Slats	Solid & straw	Method & Length	System
Feeding stalls	0.43[a] (0.70)	0.58[b] (0.81)	0.63[a] (0.79)	0.38[b] (0.68)	0.50[a] (0.74)	0.70[b] (0.84)	0.32[c] (0.59)	0.036	0.044
Communal kennel	0.46[a]	0.27[b]	0.24[a]	0.48[b]	0.25[a]	0.23[a]	0.61[b]	0.026	0.032
Dunging area	0.12	0.15	0.13	0.14	0.25	0.07[b]	0.08[b]	0.029	0.036

[abc] Means with different superscripts within factors differ significantly. See text for *P* values.
Figures in parentheses indicate proportion of the time in stalls which was spent lying.

Table 2 **Changes throughout the experimental period in occupation of zones within pens.**

Pen zone	Day							
	1	2	3	10	17	24	31	SEM
Feeding stalls	0.63[a]	0.58[ab]	0.53[b]	0.49[bc]	0.45[c]	0.42[c]	0.45[c]	0.025
Communal kennel	0.27[a]	0.31[ab]	0.35[bc]	0.39[bc]	0.38[bc]	0.39[bc]	0.43[c]	0.024
Dunging area	0.10[a]	0.11[a]	0.12[a]	0.12[a]	0.17[b]	0.19[b]	0.12[a]	0.014

[abc] Means with different superscripts within factors differ significantly. See text for *P* values.

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Neither feeding method nor barrier length had any significant effects on time spent in the dunging area either lying (0.080 overall) or standing (0.054 overall). The dung disposal system had no effect on time spent standing in this area, however time spent lying was increased on the compost compared with slats and straw (0.19, 0.02 and 0.03 respectively, $P<0.01$, SEM = 0.033).

Use of various zones within pens changed significantly throughout the experimental period with decreasing occupation of the feeding stalls, increasing occupation of kennels and an increased use of the dunging area in the mid period of the experiment (Table 2). The latter was due to the effect of the compost treatment. The occupation of the dunging area on this treatment rose from day 1 (0.12) to days 17 (0.38) and 24 (0.39) with a tendency to fall on day 31 (0.26). There were no significant changes in occupation of the dunging area throughout the experiment on the slats and straw treatments resulting in a significant interaction of day x dunging system ($P<0.001$, SEM = 0.043).

The compost showed similar changes in temperature and moisture content with each group of sows. Prior to introduction of sows, broiler house litter was scattered on the surface and dug in manually to aerate the top 200mm of compost. Two days later the temperature rose to around 38°C with a moisture content around 600g/kg. Following the introduction of sows, compost temperature fell to around 29°C rising 4–5°C temporarily following each weekly aeration. The area of compost at the rear of the feeding stalls was heavily tramped by sows' feet and accumulated urine excreted while sows stood in the stalls. The surface of this area together with the compost in the vicinity of drinking nipples became waterlogged 2–3 weeks after occupation. This reduced microbial activity and compost temperatures fell to around 20°C with moisture content rising to 740g/kg. The high moisture and low temperature areas gradually increased throughout the compost area.

The use of zones within pens showed circadian variation, with the pattern of use depending both on dung disposal system and length of feeding stall (Figure 1). There were significant interactions ($P<0.001$) between time of day, stall length and dung disposal system for occupation of stalls and kennels, with the interaction approaching significance ($P = 0.08$) for the dunging area. The standard errors of means for these interactions were 6.8, 5.2 and 5.5 expressed on a percentage basis for stalls, kennels and dunging area respectively. In all but one type of pen the occupation of stalls rose to peak values of around 75 per cent for the hours around feeding time. A similar value occurred in the exceptional pen (slatted with full length stalls) around feeding time but this was the lowest value throughout 24 hours in this type of pen. In pens with full length stalls combined with either compost or slats there was a low level of occupation of kennels with little variation between day and night. In contrast all other systems showed a marked circadian pattern with high use at night, particularly on straw systems, and low use around and after feeding time. With all dung disposal systems, full length stalls were used more at night than half length stalls. This effect of stall length was greatest on slats and compost systems and least on the straw system (Figure 1).

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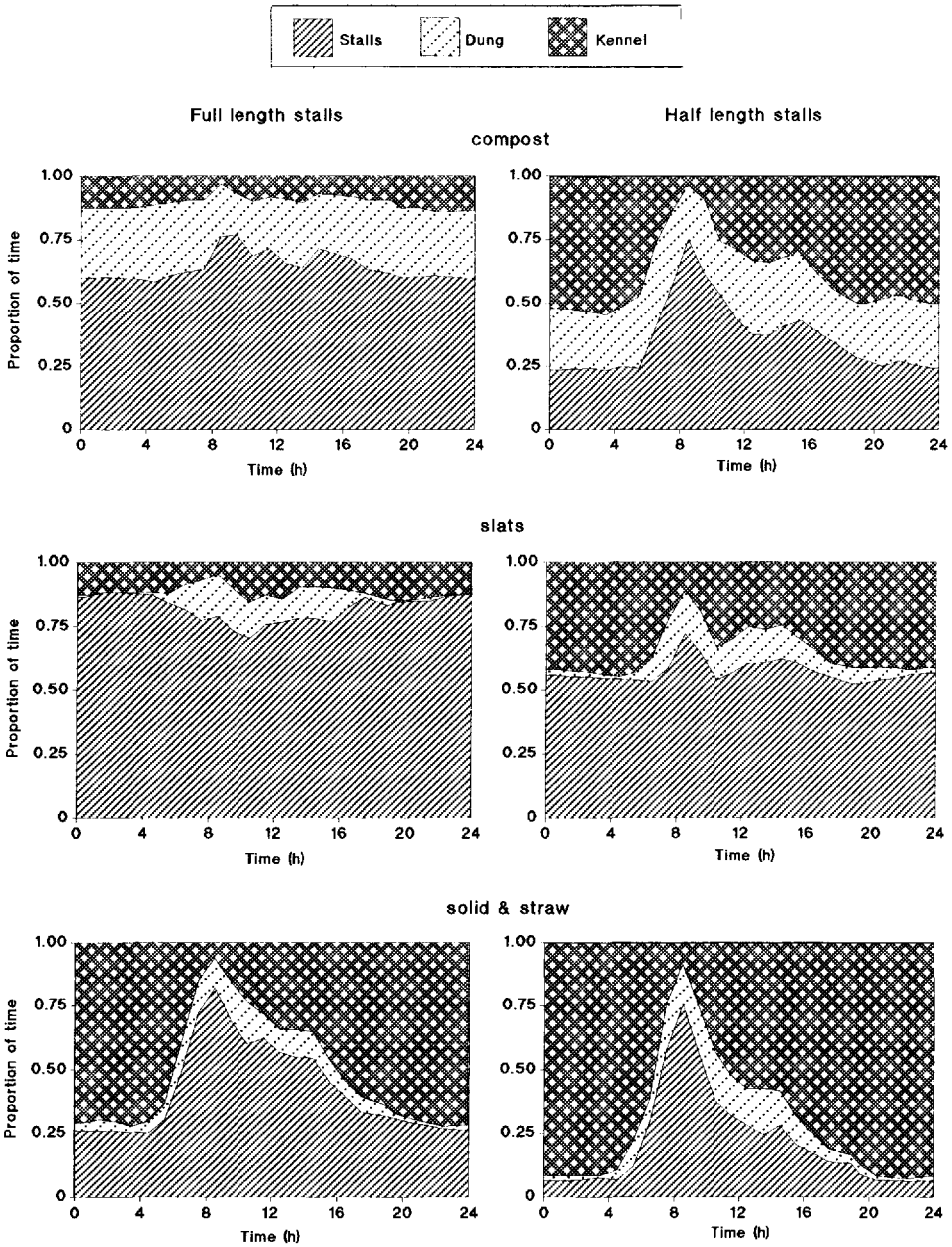

Figure 1 **Circadian patterns of time spent by sows in zones of various types of pen.**

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Discussion

Over the whole experiment sows spent half their time in individual feeding stalls in contrast to 19 per cent reported for gilts in similar housing (Brouns 1993). There are a number of possible explanations for this behaviour including previous history, ambient temperature, and excretion behaviour. Sows in the present experiment were previously housed in stalls and farrowing crates for at least one parity. Confinement housing encourages abnormalities in behaviour such as stereotypies and apathetic behaviour (Fraser & Broom 1990).

The similarity of feeding stalls, particularly full length stalls, to confinement stalls may encourage sows to use a system with which they are familiar as Dawkins (1976) found with hens habituated to cages. However, the reduction in use of stalls in the pens with straw may indicate a plasticity of response to this novel environment which occurred early in the experimental period. Nevertheless the possible influence of previous confinement housing should not be minimized. For example, inappropriate dunging behaviour during the first few days, consequent on initial abnormal social behaviour and preference for familiar individual stalls, may have established excretory locations and prejudiced longer term use of kennels particularly when unbedded.

The possibility that ambient temperature influenced the use of pen zones was investigated. Regressions were calculated for ambient temperature against the occupation of feeding stalls both at night (2000h to 0400h) and following feeding during the day (0900h to 1700h). There were no significant relationships between minimum temperature in the house and night-time occupation of stalls. The regression of occupation of stalls during the day on maximum temperature was significant ($P<0.001$, $R = 0.64$) for pens with straw but not for the slatted or compost systems. A similar finding was reported by Botermans and Andersson (1993) for growing pigs. The maximum daytime temperature in the present experiment ranged from 15°C to 29°C over the experimental period with a mean value of 23°C. The equivalent minimum temperatures were 8°C, 18°C and 13°C respectively. These night-time temperatures were below the lower critical temperature for non-lactating sows on restricted feed intakes (Close & Cole 1986) and would be expected to increase use of communal areas at night with sows huddling to reduce heat loss. The absence of this behaviour in the slatted floor systems may have been due to a preference for dryer floors in the feeding stalls as demonstrated by Hutson *et al* (1993). This may also explain the lower use of half length feeders; casual observations indicate that unbedded kennels and the solid area behind half length feeders were used on occasions for excretion.

However, the relatively high night-time use of full length feeders in the pens with straw may indicate a preference for solitary rather than gregarious behaviour on occasions when that choice is available. In a survey, Svendsen *et al* (1992) found a marked variation between commercial herds using individual feeding stalls: a higher proportion of sows preferred to remain in the stalls after feeding in herds with more thin and more nervous sows and with higher injury scores. Preference measures, as Rushen and de Passillé (1992) pointed out, should not be over interpreted as indicators of welfare. Nevertheless the question arises from the present results of whether welfare is improved by the provision of choice between individual and communal sleeping areas.

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The increased use of the dunging area with compost compared with slatted or solid dunging areas indicates a preference for lying on a substrate rather than bare concrete (Kay & Smith 1992), but this declined with time as moisture content of the compost increased, a problem highlighted by Kay (1992). This contributed to an increasing preference for feeding stalls in the compost pens although this preference was already high even in the initial weeks of the experimental period. Again this supports the possibility of a need for choice between communal and individual lying areas.

Animal welfare implications

The proportion of time spent by sows in either communal kennels or in individual stalls showed major changes depending on the facilities incorporated in the design of the pen. In all combinations of design examined here, sows made use of both kennels and stalls as resting areas. With the cautionary note that behaviour in this experiment was likely to be influenced by sows' previous history of confinement housing, offering the choice of communal or individual rest areas may improve welfare for group-housed dry sows. The addition of even a small amount of straw increases the use of communal kennels considerably. The preference for a substrate is also demonstrated by the increased use of the dunging area in the compost systems. These changes in behaviour suggest a lower level of welfare in slatted floor pens, a system incompatible with the provision of substrate and yet frequently preferred by producers in regions where straw availability is limited.

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