Effects of Feed Station Design on the Behaviour of Group-Housed Sows Using an Electronic Individual Feeding System

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ABSTRACT


A series of 72-h video studies investigated the behaviour of sows using a computer-controlled electronic identification and feeding system in relation to feed station design. A Pig Code double-entry feed station was modified to provide an optional forward exit on one side, while sows on the other side continued to reverse out. Two groups of 19 sows used each side in turn and their behaviour was recorded after a period of adaptation. Sows given the opportunity used the forward exit on nearly all occasions, unless it was blocked by another animal. A forward exit resulted in more station visits daily (7.2 vs. 4.6, P < 0.001), but non-feeding visits were of shorter duration so that total occupation time was similar (24.4 vs. 26.5 min per sow). Sows learnt to circumvent the computer-controlled mechanism locking the rear gates and showed aggression towards animals in the station. This behaviour had not been observed in the previous 28 months of study. A subsequent study of 39 sows using a single station, where the rear gate and forward exit were both operated mechanically by the sow, showed a mean daily occupation time of 29.7 min per sow in 3.9 visits. A forward-exit station with positive closing of the rear gate is desirable, but some problems with station design remain to be solved.

INTRODUCTION

Individual confinement of dry sows in stall or tether housing predominates in many countries because such systems minimise aggression and permit individual feeding and management at low capital cost (Riley, 1983). However, the restriction of movement and the high incidence of abnormal behaviour often seen in such systems have given rise to concern about the welfare of the

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animals (Ministry of Agriculture, Fisheries and Food, 1983). Electronic technology developed for feeding concentrates to dairy cattle has recently been adapted for sows, permitting automatic individual rationing of group-housed animals (Lambert et al., 1983; Edwards et al., 1984a). This system has now been incorporated in a wide range of housing designs, allowing freedom of movement and social interaction of sows (Brade et al., 1986). Such housing can be designed at an overall cost similar to that for individual-confinement systems.

With the electronic feeding system, sows carry an electronic identification device on a collar or ear tag and feed sequentially at a computer-controlled feed-dispensing station. The design of this station is important in maximising the number of sows which can share it, whilst minimising aggression. Earlier studies carried out with a “double-entry” feed station design, which allowed 2 separately housed groups of sows to share the same feed dispensing system, indicated a capacity of up to 50 sows (Edwards et al., 1984a). However, studies of this and other rear exit designs showed that, early in the feed cycle, a number of sows congregated behind the feed station and hindered the sow backing out (Edwards et al., 1984b; Smith et al., 1986). Although this did not cause major problems with aggression, it appeared that a forward exit system might improve station use. The following studies were, therefore, undertaken to investigate the effects of different feed station designs on the behaviour of sows using the station.

METHODS

Experiment 1

This experiment compared the behaviour of sows which had either to reverse out of the feed station or could use an optional forward exit. The Pig Code electronic feeding system which was used has been described in detail elsewhere (Edwards et al., 1984a). Two separately housed groups of sows share a feeding station by means of a moveable gating arrangement within a triangular feeding stall (Fig. 1a). When a sow who is eligible for food enters the station, the gates of both rear entrances are locked shut electronically. They remain locked while feed is being dispensed and are unlocked by a signal from the computer, sent 1–2 min after the last food drop. The original feed station design required sows to reverse out from the station into the group from which they came. This design was modified to incorporate an optional forward exit on one side of the station via a sow-operated, one-way gate. The gate was similar in construction to the rear entry gates, with horizontal bars hinged from each side and closed by a strong spring.

The feed station was sited in a straw-bedded, kennelled building with access for sow groups housed in identical sides of the house (Fig. 2). The feed station
Fig. 1. The design of the feeding stations used in the experiment. A = feed hopper and trough, B = entrance, C = exit passage, D = one-way exit gate. ---- shows alternative positions of moveable parts. (a) Experiment 1. Computer-operated, double-entry station. Sows in the left group reverse out, sows in the right group have an optional forward exit. (b) Experiment 2. Sow-operated stall modified to have an additional forward exit passage.

stood on a raised central concrete strip, 200 cm across, with half in each pen. The building had natural lighting and a 100-watt bulb positioned over the feed station remained on throughout the night. The feeding programme selected allowed sows to obtain their daily ration in a single visit to the station. The feeding cycle started at 04.00 h when the new daily ration for each sow became available. The station dispensed food to each sow in turn by successive drops of 100 g given at intervals of 30 s until the sow had consumed her full allocation. If a sow left the station before completing her ration, food dispensing stopped and the sow could return later in the day to receive the remaining food. Sows which had already fed could re-visit the station, but entry gates remained unlocked and they received no further food. The daily ration for individual sows varied between 1.8 and 2.4 kg of a pelleted diet (13.0 MJ digestible energy and 160 g crude protein kg$^{-1}$) with the level of feeding determined by the allocation of animals within a concurrent long-term nutrition experiment.

Two groups of 19 multiparous sows, previously trained to use the electronic
feeding system, were used in the investigation. One group initially used the side of the station with the original rear-exit design, while the other group used the modified side with the optional forward exit. After allowing 1 week for the sows to adapt to the station design, a 72-h continuous video recording of behaviour in the vicinity of the feed station was made. Sows were individually numbered on their backs and the timing, sow identity and mode of exit determined for all visits to the station. A flag marker magnifying the movement of the mechanism locking the rear gates indicated the food dispensing time, defined as the period for which these gates were locked. At the termination of each individual visit to the station, a count was made of the number of sows queuing at the entry and exit points. A sow was defined as queuing if she was within 2 m of the gate and facing towards it.

After the first video recording had been made, the groups exchanged pens and the procedure was repeated. The number and duration of visits made by individual sows when using the station with or without the optional forward exit were compared using the Wilcoxon matched-pairs, signed-ranks test and the frequency of displacements from the feed station compared using the Chi-squared test. The stability of the feeding order was examined using the Kendall Coefficient of Concordance (Siegel, 1956).

Fig. 2. Plan of housing used in the experiments. A = kennelled lying area, B = dunging and activity area, C = raised central area, D = drinkers, E = isolation pen, F = feed station (---- Expt. 1, —— Expt. 2), G = observation area.
Experiment 2

After completion of Experiment 1, the building was modified and a new group of sows used to investigate a completely different design of feeding station. The computer-operated “double-entry” stall was replaced by a sow-operated single stall, the Piper Feed Race (Fig. 1b). With this stall, a sow entering the station pushed back a shoulder bar as she approached the trough. This bar was linked to the rear gate, which was then pulled shut behind the sow and locked mechanically while she remained in the station. When the sow chose to leave the station, she pushed open a side exit gate which simultaneously released the lock on the rear gate, allowing the next sow to enter.

A single group of 39 multiparous sows was housed in the same building and given access to the complete pen used in the previous experiment (Fig. 2) by removing the dividing partition. After a 1-week period for adaptation to the new system, a 72-h continuous video recording of behaviour in the vicinity of the feed station was made. This recording demonstrated some problems with the side-exit door of the station, which gave direct access back into the group area. Excessive congregation of sows outside this door hindered the sows trying to leave the station and resulted in some sows entering the station from this direction. The station design was, therefore, modified by creating a 2-m passage between the exit from the feed station and a one-way gate back into the group area. After a 1-week adaptation period to this new design, a further 72-h video recording of behaviour was made with a group of 39 sows. The time of all visits to the station was recorded and a small light bulb used to indicate when the feed dispensing mechanism was operating.

RESULTS

Experiment 1

Overall, the 38 sows occupied the feed station for 67% of the time, with 33% being feed dispensing time. The station was continuously occupied from the start of the daily cycle at 04.00 h until 13.00 h, by which time 87% of sows had always fed. On 5 of the recorded days, all sows had fed by 14.30 h and on the sixth day one animal fed later at 16.32 h. Sows maintained a consistent feeding order when all 38 sows were considered over the 6 recorded feeding cycles ($W=0.791, P<0.001$) and the degree of consistency was even greater when considered separately for each group of 19 sows ($W=0.854$ and $0.809, P<0.001$). Both groups showed an increase in the consistency of the feeding order when comparing the two 3-day recording periods ($W=0.886$ and $0.922, P<0.001$ for the group initially using the rear exit side of the station; $W=0.865$ and $0.881, P<0.001$ for the group initially having the optional forward exit).
TABLE I

Behaviour of sows (% of occasions) using the Pig Code feed station modified to give an optional forward exit

<table>
<thead>
<tr>
<th></th>
<th>Feeding visits</th>
<th>Non-feeding visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward exit used</td>
<td>97</td>
<td>89</td>
</tr>
<tr>
<td>Sow reversed out:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sow lying across exit</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Threatening sow outside exit</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Exit clear</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

These results indicate that the stability of the feeding order increased with time since formation of the group, but was unaffected by station design.

After all sows had fed, station occupation time decreased to only 15% of the period between 17.00 and 23.00 h, before starting a gradual increase again in anticipation of the beginning of the next feed cycle. The station was occupied by a lying sow for only 4% of the observation time and this behaviour was never observed until after all of the sows had fed for that cycle. The mean station-occupation time per sow per day of 25.4 min (range 11.7–137.3 min) was made up of 12.6 min (10.0–16.0 min) when feed was being dispensed, 0.7 min (0–17 min) delay before leaving the station after feeding and 12.1 min (0–125.3 min) during a further 4.9 (0–18.3) non-feeding visits to the station. Sows showed great individual variation in the number and duration of non-feeding visits. This was not related to the level of feed they were receiving. Individuals were consistent over time in their ranking for the number of non-feeding visits made each day. For the 6 recorded days $W=0.650$ and 0.633 ($P<0.001$) for the 2 groups of 19 sows.

All sows with the option of a forward exit used it on the great majority of occasions (Table I). After feeding, sows reversed out on only 3/114 occasions and in each case this was because the forward exit was blocked by a sow outside the gates. The forward exit was also used on the majority of non-feeding visits and many of the occasions when sows reversed out were again attributable to blocking of the forward exit by another animal.

The behaviour of sows with the forward or rear exit system is compared in Table II. With a forward exit, sows made more non-feeding visits to the station ($P<0.001$), but these were of shorter duration ($P<0.001$) and total occupation time was not significantly affected. The mean number of animals queuing for entry to the station whenever it became vacant did not differ between groups with or without a forward exit, being 2.4 and 2.7, respectively, for the first 12 h of the cycle and 0.2 and 0.3, respectively, for the second 12 h of the cycle.

The video recordings demonstrated a major problem with the feed station
TABLE II

The effect of feed station design, with a forward or rear exit, on sow behaviour

<table>
<thead>
<tr>
<th></th>
<th>Forward exit</th>
<th>Rear exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station occupation time (min per sow per day)</td>
<td>24.4</td>
<td>26.5</td>
</tr>
<tr>
<td>Duration of feed dispensing (min per sow per day)</td>
<td>12.6</td>
<td>12.6</td>
</tr>
<tr>
<td>Duration of non-feeding visits (min per sow)</td>
<td>1.6</td>
<td>3.6***</td>
</tr>
<tr>
<td>Total no. of visits per sow per day</td>
<td>7.2</td>
<td>4.6***</td>
</tr>
<tr>
<td>Feeding visits (% of occasions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sows followed into station</td>
<td>41</td>
<td>43</td>
</tr>
<tr>
<td>Feeding sow displaced</td>
<td>13</td>
<td>3**</td>
</tr>
<tr>
<td>Sow exited before rear gates unlocked</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>Sow attempted to exit backwards before gates unlocked</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Exit delayed ≥ 2 min after gate unlocked</td>
<td>5</td>
<td>14*</td>
</tr>
</tbody>
</table>

*P=0.05; **P=0.01; ***P=0.001.

design. Any sow following immediately behind a sow entering the station was able to pass her head and shoulders through the rear gates before they could swing shut and lock. This occurred on a high proportion of feeding visits (Table II) and meant that food was dispensed to sows which were not protected by locked rear gates. As a result of pushing and biting from behind, a number of these sows were displaced from the station leaving food in the trough. The animals, therefore, learnt that by biting a sow in the station they could sometimes obtain food and this resulted in a high incidence of damaged vulvas in both groups. Sows with a forward exit were more frequently displaced from the feed station (P < 0.01) since they had a better escape route when attacked from behind.

With a delay of 2 min between the last drop of food and the unlocking of the rear gates, sows frequently left the station by the forward exit before the rear gates unlocked, removing the possibility of being pushed or bitten from behind by incoming sows. Sows on the rear-exit system frequently attempted to leave before the back gates unlocked and reversed out rapidly immediately unlocking occurred. However, a higher proportion of sows tended to delay exit for 2 min or more on the rear-exit system (P < 0.05).

Experiment 2

Initial observations on the sow-operated forward-exit station showed problems caused by sows congregating outside the exit gate. The construction of a passage separating the exit from the feed station and the point at which the sow rejoined the group improved the ease with which a sow could leave the
station. The mean number of animals waiting outside the exit gate was reduced, both for the whole 24-h period (0.3 with passage, 1.1 without, \( P < 0.001 \)) and, more important, for the first 12 h of the cycle when feed was dispensed (0.5 with passage, 1.5 without, \( P < 0.001 \)).

Sows were allowed to adapt to this design modification before making the video recordings described in Fig. 3, which shows the pattern of feed station use with the single, sow-operated feeding stall. The 39 sows occupied the feed station for 80% of the time, varying between days from 77 to 82%, with 30% being feeding time and 12% time that a sow was lying in the station. The mean daily occupation time of 29.7 min per sow was made up of 10.9 min feeding, a delay of 8.0 min before leaving the station after feeding and a further 2.9 non-feeding visits later in the day. The delay in leaving the station after feeding varied widely between sows, from 0 to 80 min, with some animals lying for a period and preventing access of other sows waiting to feed.

Although the station design worked well during the period of the video study, some problems subsequently developed. Some sows learnt to follow closely behind a sow entering the station and force her to exit before feeding. A few animals also learnt how to enter the station through the forward-exit gate and displace sows which were feeding. These observations indicated that further design modifications were necessary.

DISCUSSION

Results obtained in this and previous studies indicate that group housing with electronic individual feeding of dry sows offers a commercially-acceptable
alternative to housing systems involving individual confinement (Edwards and Riley, 1986). The system requires a number of animals to feed sequentially at one feed-dispensing station and this has given rise to a number of questions regarding the welfare of animals under these circumstances. It is necessary to establish that all animals can obtain their correct daily ration, that queuing for entry to the station is not excessive, that the welfare of the late-feeding animals is not adversely affected and that the feed station does not become a focus for excessive aggression between sows. Correct station design is important for all of these factors.

As in previous studies (Edwards et al., 1984b; Brade et al., 1986; Smith et al., 1986), up to 40 sows were able to share one feeding station with plenty of opportunity for all animals to feed in the 24-h period. The animals established a relatively consistent feeding order so that each individual received her feed at ~24-h intervals, as in any conventional once-daily feeding system. Some queuing occurred at the entrance to the feed station, but this was not excessive since late-feeding sows generally waited until the more dominant sows had fed. Provision of an optional forward exit from the station did not significantly reduce overall occupation time or the number of animals queuing in comparison with a rear exit system. However, the sows showed a clear preference for using a forward exit from the feed station when one was available, whether or not animals were waiting to enter from behind. The design and siting of the forward exit were both important for a successful system. If sows entered the station from the wrong direction major problems resulted, since a sow in residence was then threatened from both front and rear. Although the design of the exit gate worked during the period of the studies reported, it subsequently proved inadequate and new designs are being investigated. It also proved important to site the station so that sows were not encouraged to congregate or rest immediately outside the forward exit. Siting the feed station away from the lying area of the group, and making a passage of at least 2 m between the exit from the feed station and the gate back into the group, helped prevent this problem. Gravas (1986) compared the behaviour of sows in 2 experiments, the first with rear exit and the second with forward exit, and found sows spent a much greater time standing in the station without feed in the former case. However, comparison is difficult since the experiments involved small group size (<10 sows per station) and a 3 times per day feeding schedule, giving occupation times more than double those in the present study.

The overall pattern of feed-station usage recorded in this study differs from that reported earlier for large groups of sows on the farm with the same design of feed station (Edwards et al., 1984b). Sows in the present study made more visits of shorter duration and exited more quickly after feeding. In the earlier studies, no problems with aggression at the feed station occurred, feeding sows were never displaced and vulva damage was very rare. This situation prevailed for >2 years prior to the present study. The reason for the greater aggressive-
ness recorded here is unknown since genotype, diet, feed level and group size had all been used previously without problems. Once aggressive behaviour began to occur, the design of the feed station proved inadequate since sows could circumvent the locking mechanism of the back gates and attack a feeding sow. A similar problem with this station design has been reported for a commercial farm (Beckett et al., 1986). It is essential that station design precludes all possibility of aggression directed at a feeding sow since, if rewarded by obtaining additional feed, such behaviour quickly escalates. The type of computer-locked rear gate used in this experiment was, therefore, not acceptable.

The second experiment examined a different design of feed station in which the gates were mechanically operated by the sow herself. This meant that she could remain fully protected in the station for as long as she chose, even if no feed was available. It is possible that this design of station might result in excessive individual occupation time and reduce the number of sows which could share each station, but this was not the case in the present study. However, some sows remained lying in the stall for long periods of time and could not be dislodged by others waiting to feed. This could cause problems by delaying feeding of low-ranking sows, and the fitting of an anti-lying bar along the floor is to be recommended in such station designs.

It can be concluded that a station with a strong positive closing action on the rear gate, a means of discouraging excessive occupation time after feeding and a reliable forward exit is the most desirable design. Investigations into ways of achieving these aims are continuing.

ACKNOWLEDGEMENTS

We thank all staff at Terrington E.H.F. who assisted with these investigations.

REFERENCES


RESUME


Des séries d’études portant sur des vidéos d’une durée de 72 heures, ont été effectuées pour surveiller le comportement de truies équipées d’identification électronique et utilisant un système d’alimentation commandé par ordinateur, en fonction de la conception des postes d’alimentation. On a modifié un poste à double alimentation, codé pour les porcs afin de créer une sortie facultative vers l’avant, latéralement, alors que les truies se trouvant de l’autre côté continuaient à reculer pour sortir. Deux groupes, de 19 truies chacun, ont utilisé tour à tour chaque côté, et on a enregistré leur comportement après une période d’adaptation. Lorsqu’elles en ont eu l’occasion, les truies ont presque toujours utilisé la sortie avant, à moins que celle-ci n’ait été bloquée par un autre animal. La sortie avant a entraîné un nombre de visites journalières plus grand (7.2 contre 4.6; P < 0.001) mais les visites sans alimentation ont été d’une durée plus courte, de sorte que le temps d’occupation total a été similaire (24.4 contre 26.5 min truie⁻¹). Les truies ont appris à circonvenir le mécanisme de fermeture des portes arrière commandées par ordinateur et se sont montrées agressives vis-à-vis des animaux se trouvant dans le poste. Ce comportement n’avait pas été observé au cours des 28 mois précédents de l’étude. Une étude ultérieure portant sur 39 truies utilisant un même poste, dont la porte arrière et la sortie avant étaient toutes deux actionnées mécaniquement par la truie, a indiqué un temps d’occupation moyen journalier de 29.7 min truie⁻¹ au cours de 3.9 visites. Il est souhaitable d’avoir un poste comportant une sortie avant fermeture effective de la porte arrière, mais il reste encore à résoudre certains autres problèmes découlant de la conception du poste.

ZUSAMMENFASSUNG


In einer Reihe von 72-stündigen Videoaufnahmen wurde das Verhalten von Sauen bei der Verwendung eines rechnergesteuerten, elektronischen Identifikations- und Fütterungssystems mit Bezug auf Fütterungstellekonstruktion untersucht. Eine Pig-Code-Doppelfütterungstelle wurde so modifiziert, daß den Sauen auf der einen Seite wahlweise ein Ausgang in vorwärtsrichtung zur Verfügung stand, während die Sauen auf der anderen Seite die Fütterungsstation weiterhin rück-
warts verließen. Zwei Gruppen von jeweils 19 Sauen benutzten abwechselnd beide Seiten und nach einer Eingewöhnungszeit wurde ihr Verhalten gefilmt. Wenn sich den Sauen die Möglichkeit bot, benutzten sie fast immer den Vorwärtsausgang, solange er nicht durch ein anderes Tier versperrt war. Die Möglichkeit eines Vorwärtsausgangs erhöhte die tägliche Besuchs frequenz der Fütterungsstelle (7.2 gegenüber 4.6, \( P < 0.001 \)), Besuche ohne Fütteraufnahme waren jedoch von kürzerer Dauer, so dass die gesamte Anwesenheitszeit ähnlich blieb (24.4 gegenüber 26.5 Minuten Sau \(^{-1}\)). Die Sauen lernten, wie das computer gesteuerte Verriegelungssystem für die Türen hinter ihnen umgangen werden konnte und verhielten sich aggressiv gegenüber den in der Fütterungsstelle befindlichen Tieren. Ein solches Verhalten war in den vorausgegangenen 28 Monaten der Untersuchung nicht beobachtet worden. Eine anschließende Untersuchung mit 39 Sauen in einer Einzelfütterungsstelle, in der sowohl der Rückwärts- wie der Vorwärtsausgang mechanisch durch die Sau betätigt wurde, zeigte eine durchschnittliche tägliche Anwesenheitszeit von 29.7 Minuten Sau \(^{-1}\) in 3.9 Besuchen. Eine Fütterungsstelle mit Vorwärtsausgang und positiver Verriegelung des Rückwärtsausganges ist wünschenswert, jedoch bleiben einige Konstruktionsprobleme zu lösen.