Providing pregnant sows in an electronic sow feeding system with access to hay silage

Background

In Sweden, the interest in electronic sow feeding (ESF) systems for group-housed gestating sows is growing. The use of ESF systems is associated with several benefits as the system allows for e.g. individual feeding of animals (animals are identified by transponder ear tags and fed once at a time) and saves space when sows are housed in large groups. The latter is particularly relevant, due to the recent modification of the Swedish legislation concerning housing of gestating sows. Regulations from the Swedish Board of Agriculture state that each sow must have access to at least 2.05 m^2 when sows are housed in groups of 40 or more (Jordbruksverket, 2019). With the current available housing systems, this space allowance can only be achieved in an ESF system. In comparison, a system with individual feeding stalls, a bedded area and a slatted area (3-room system) requires at least 2.9 m^2 per sow, and systems with individual feeding stalls and a deep litter area have a space requirement is 3.5 m^2 per sow, making the ESF system the most efficient system with regards to space.

Figure 1 A picture of one of the study pens for the pregnant sows. The electronic sow feeder can be seen in the centre of the pen and along the sides of the pen the lying areas are located.

Housing gestating sows in an ESF system is, however, also associated with several challenges. Gestating sows are fed restrictive amounts of concentrates to reduce reproductive problems, which means that the sows may have a lasting motivation for eating/feed seeking. Such motivation combined with group housing on relatively confined space, will result in increased levels of aggression, following increased competition (Bench et al., 2013). Additional factors such as the ESF settings further influence the occurrence of e.g. vulva biting and aggression (Olsson et al., 2011). The high competition between sows within an ESF system calls for additional initiatives if the wellbeing of the sows is to be safeguarded. In particular low ranking sows, which are often the young animals (Arey, 1999) may experience lowered welfare in group housing systems. These sows e.g. have more injuries and are positioned lower in the feed order(O'Connell et al., 2003).

One way to reduce sow aggression and competition around the ESF could be by supplementary feeding with roughage. O'Connell (2007) found that sows in large dynamic groups consume an average of 1.8 kg grass silage daily, and further saw indications of grass silage increasing satiety as indicated by a reduction in stereotypic sham chewing. Furthermore, O'Connell (2007) found that the silage racks were most visited by newly introduced sows, which are often considered lower ranking, suggesting that access to such racks in particular may benefit low ranking animals. The current study therefore aimed to reduce competition and aggression and improve the welfare (reduce the number of skin and vulva lesions) among restrictively fed pregnant sows housed in an ESF system.

Methods

Housing and management

This study was conducted at a commercial pig-producing herd in Skåne with 660 Topigs Norsvin TN70 hybrid sows. The study period lasted from December 2019 until September 2020. At the farm sows were loose-housed throughout the production cycle as is required according to Swedish animal welfare regulations (Jordbruksverket, 2019). Sows farrowed every 2nd week and the farrowing interval was 22 weeks.

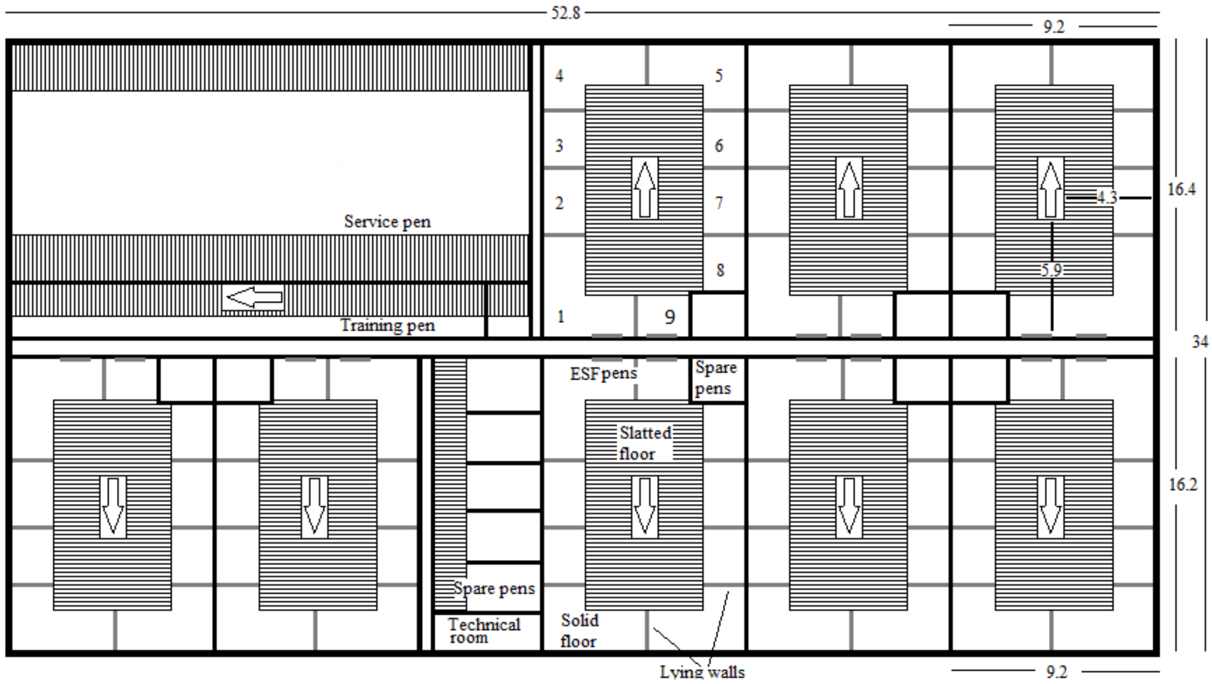

Figure 2 A sketch of the gestation unit where eight ESF pens for pregnant sows were located along with a pen for the training of gilts in the use of an ESF (training pen 15,3 x 4,3) before insertion in an ESF pen. The service pen (feeding stalls on each side (on the slatted area as indicated by the striped area in the service pen) of a deep bedded area) was located next to the training pen. In the sketch, spare pens refer to pens used for housing of boars and sick animals. The square with an arrow refers to the ESF station and the arrow points in the direction sows walked when going through the ESF. The grey squares on the front wall of the ESF-pens indicates the location of the straw racks (only racks in test groups were supplied with hay silage). All measures provided are in meters.

In the gestation unit, sows (including gilts) were housed in groups of 65.8 (59-74) (average, range) at introduction in the study groups. The unit comprised eight similar pens with an ESF (BoPil Schauer) located in the center of each pen (Figure 1 and 2). A ninth pen in the gestation unit was used for training of gilts in use of the ESF. Before the gilts are moved to the training pen, they have access to an ESF with free access to feed. After this, they are moved to a training pen where they are fed once a day. After each day the eating order is checked to make sure that everyone has eaten, and if not, it shows which gilts need to be helped in manually.

Four to five days after 1st service sows were moved to the gestation unit where they were housed in stable groups. In each pen there were nine lying areas with solid floor separated by 50 cm high solid lying walls. Water was provided *ad libitum* in a drinking bowl located on the side of the ESF, on the side of the spare pen and inside the ESF with every feeding (Figure 3). The feeding day started at 07:00 and lasted until 22:00. At feeding sows received 100 g dry feed for pregnant sows (12.1 MJ OE/9.1 MJ NE, crude protein 124 g/kg, Lantmännen) per feed drop. Pens were cleaned manually once daily.

Seven days before expected parturition sows were moved from the gestation unit to individual loose-housing pens in the farrowing unit.

All animals were inspected daily as part of the normal herd routine and sick and injured animals were treated/euthanized/moved to sick pens when needed, the need was evaluated by the farm staff.

Figure 3 The inside of the electronic sow feeder. To the right the feeding tray can be seen.

<u>*Experimental set-up & recordings*</u>

The experiment was conducted using a two factorial design where sows either were provided with hay silage (5 test groups) or not (4 control groups). On a daily basis hay silage was provided in the lying areas (~2 kg silage/daily) and in two straw racks (0.22 m^3, 110 x 70 x 50 cm, 3 cm beam distance, Jyden A/S, Denmark) (~16 kg silage/daily) the three first days after sows were moved to the ESF-pen. After these days hay silage was no longer provided in the lying areas. Both test and control groups received ~2 kg of intact straw in the lying areas each day. Every second group of sows that entered the ESF pens was included as a test group (silage) in the study whereas the other groups were included as control groups. Upon insertion (day 111; 1 group day 110), and on days 107 (1 group day 100), 83 (1 group on day 86), and on day 9 *pre p*, screenings of the clinical conditions of a sub-set of sows (at introduction 100 silage sows (5 groups) and 80 control sows (4 groups); 5 sows in parity 1, 5 sows in parity 2, 5 sows in parity 3-4 and 5 sows in parity 5-6 per group), were performed according to the score in Table 1. Skin lesions were scored for the front (face, shoulders and ribs), hind (loin and flank) and rump (excluding vulva and the area around the vulva) of the sows.

In addition to the ocular scoring of body condition, measurements of back fat were performed. For this a Renco Lean-Meater ultrasound equipment was used. The probe was place on the right side of the sow, along the last rib and 5 cm down the side from the spine. Rapeseed oil was used as contact solution and two layers of back fat were measured.

Table 1 Clinical scoring conducted on a sub set of sows in each electronic sow-feeding pen

Measure	Score
Skin lesion	'1' ≤ 5 skin lesions '2' 5-10 skin lesions '3' ≥ 11 skin lesions
Body condition score	'1' skinny, hips and hip bone can be recognized visually '2' slim, ribs and hip bones can be recognized when applying a light pressure '3' intermediate, ribs and hip bones can be recognized when applying a firm pressure '4' ribs and hip bones cannot be seen of felt
Vulva lesions	'0' no damage to the vulva '1' small lesion (<2cm) or scar tissue visible on the vulva '2' presence of a lesion > 2cm, but the lesions is in the process of healing (scrap or crust formed), or a deformed vulva '3' presence of a bleeding lesion > 2 cm
Lameness	'0' normal gait '1' abnormal gait, all legs are weight bearing '2' lame to a degree where the affected limb can be recognised, the use of the affected limb is limited '3' severely lame, does not bear weight on the affect limb or reluctant to stand/walk

Reasons for removal of sows during gestation (sick, euthanized, empty) and production results (date of parturition, litter size, no of stillborn, use of birth assistance) were recorded by the farm staff.

Lastly, output regarding the eating order of the sows was extracted from the ESF on days 108 (1 group day 101), 84 (1 group on day 87) and 10 *pre-partum*, where the clinical scorings/screenings were also conducted.

Results & discussion

Production results

In both treatments, the average number of sow parity was 2.7 with the range 1 to 6. At introduction the groups were somewhat larger in the silage groups (67.4 (average, range 61-74)) than in the control groups (63.7 (59-68)). Information about the production results from both treatment groups can be found in Table 2. Farrowing percentage was 83.5% in the control group versus 87.5% in the silage group. In both treatments, farrowing percentage was lowest in the younger animals.

No differences in liveborn and stillborn pigs per litter were found between the groups. However, in both treatment groups the range in number of live born and stillborn piglets was larger for sows in parity 1 and 2 than in higher parity sows (parity >2).

During the study period, 20 sows were removed from the control group due to lack of pregnancy and 8 sows were slaughtered as they did not become pregnant. Three sows died and 4 had to be euthanized before parturition due to leg problems. Another 7 sows in the control group were culled due to other reasons. In the silage group, 22 sows were removed due to lack of pregnancy and 10 were slaughtered as they continuously did not become pregnant. Three sows died and 6 sows were euthanized before parturition, the main causes being inflammation in the joints, lameness or claw lesions.

In both the control and silage groups, 42 of the introduced sows did not give birth (Table 2).

Table 2. Production results. Values are shown as averages with min-max in bracket

	Control				Silage			
Parity	1-2	3-4	5-6	Totalt	1-2	3-4	5-6	Totalt
No. introduced	136	91	28	255	182	115	40	337
No. parturitions	109	78	26	213	148	109	38	295
Farrowing, %	80,1	85,7	92,8	83,5	81,3	94,8	95,0	87,5
No. liveborn per litter		)						
- average	14,9	16,8	17,3	15,9	14,7	16,5	18,2	15,8
- (min-max)	(0-22)	(5-24)	(11-22)	(0-24)	(0-23)	(2-23)	(11-24)	(0-24)
No. stillborn per litter								
- average	1,4	1,4	1,6	1.4	1,3	1,4	2,0	1,4
- (min-max)	(0-15)	(0-6)	(0-5)	(0-15)	(0-14)	(0-6)	(0-8)	(0-14)
No. not farrowed	27	13	2	42	34	6	2	42
Dead	2	1	0	3	2	1	0	3
No. culled due to								
- not pregnant/reheat	19	9	0	28	26	4	2	32
- leg problems (euthanized)	2	1	1	4	5	1	0	6
- other	4[1)]	2	1	7	1[1)]	0	0	1

1) One abortion in each treatment

Sham chewing, eating order, feed rations and feed delivery time

Before each screening of the focal animals, all sows in the pen were scanned for sham chewing (Figure 4). No numerical or statistical difference in the occurrence of sham chewing was seen

between the two treatment groups. When scanning for sham chewing, is was difficult to distinguish between sows performing sham chewing and sows chewing on straw, silage or feed.

Figure 4. A sham chewing sow with many skin lesions both to the front and hind part of her body.

Eating order was recorded for all sows in each batch (and not just for the subset of sows subjected to the clinical scorings). As can be seen from Figure 5 below, the 5th and 6th parity sows gained earlier access to the ESF while the younger sows generally visited the ESF later during the day.

Feed rations varied at the different recording occasions of eating order. At day 108 *pre-partum*, the most common feed ration was 3.9 kg (range 2.5 to 5.0 kg), compared to a feed ration of 3.0 kg (3 to 4.1 kg) at day 84 *pre-partum* and 3.8 kg (almost all sows got this ration) on day 10 *pre-partum.* Most common delivery times of these feed rations were 11-14 minutes, which means about 250-300 g feed delivered per minute.

On day 108 *pre-partum* 6 control sows (all first parity) and 24 silage sows (21 first, two second and one third parity sows) had to be assisted into the ESF. The day before the fourth screening (day 10 *pre*-partum) one third parity sow in the silage group had to be led to the ESF.

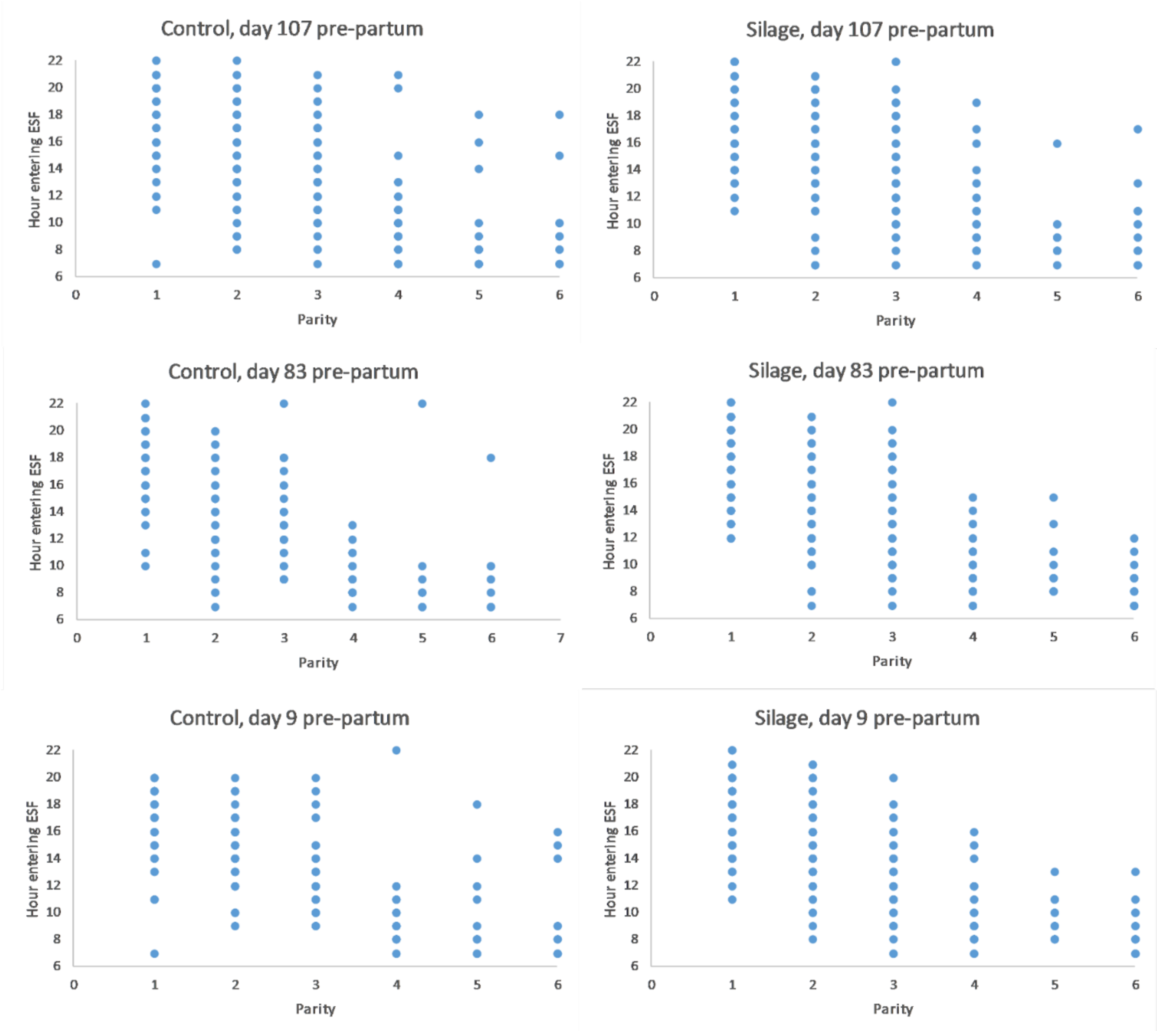

Figure 5. The hour when the sows entered the ESF, distributed with respect to parity and treatment group (control and silage) at each of the three screening days. Control refers to sows not provided with hay silage during gestation and silage to sows receiving hay silage in the gestation unit. Day pre-partum refers to the day of recording with respect to the expected date of parturition.

Clinical observations in focal animals

At farrowing, 66 control sows (out of 80 introduced) and 85-86 test sows (out of 100 introduced) remained in production (in average 17 sows per group). The results of the clinical observations are based on these animals in all four occasions.

The skin lesions recorded on the control and silage sows followed a similar trend. There was a numeric reduction in the lesion score on both the front and back of the sows over time when considering high parity sows (parity >4). There was also a slight numeric reduction in skin lesion scoring for sows in their 3rd and 4th parity whereas this reduction did not appear in the younger sows (1st and 2nd parity, Figure 6). The difference in lesion scores among the sows of different parity could indicate, that the higher parity sows (often the higher ranking sows) had a more well-established rank in the hierarchy and thus were less challenged once rank was established. It may also be that the higher-ranking sows were less affected by insertion and removal of animals throughout the gestation period whereas this addition/removal of animals may have increased the aggression amongst the younger (and lower raking) animals. Some occurrence of insertion and removal of animals happened despite working with stable sow groups in the herd.

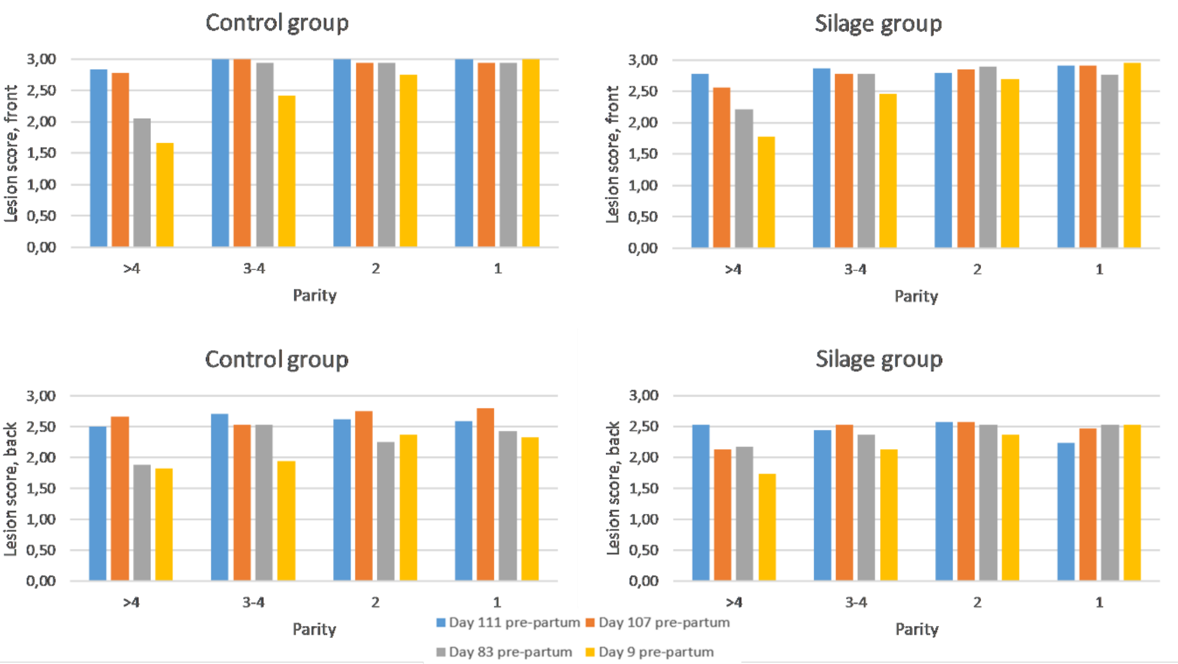

Figure 6. The lesion score for the control (sows receiving no hay silage during gestation) and silage (sows receiving hay silage during gestation) groups. The two top figures show the lesion score for the front (head, shoulder and flanks) and hind (rump) part of the sow. Day pre-partum refers to the day of scoring in relation to the expected parturition.

Sows were scored for vulva bites and signs of lameness at the same days as the scorings of skin lesions were performed.

Table 3. Results from the recordings of vulva bites

	Control	Silage

	Score				Score			
	none	1	2	3	none	1	2	3
No animals								
Vulva injuries, %								
- day -111	65	23	11	1	74	21	5	0
- day -107	74	20	5	1	79	19	2	0
- day -83	74	18	6	1	73	22	5	0
- day -9	76	15	8	1	69	12	15	5

At all screening days, and in both experimental groups, most sows (control sows (65-76%); silage sows (69-79%)) had no damage to the vulva (score 0). The proportion of sows receiving a score 1 (*small lesion (<2cm) or scar tissue visible on the vulva*) varied between 15-23% in the control groups versus 12-22% in the silage-groups, at the different observation occasions. More serious vulva lesions (codes 2 and 3) were recorded in 6-12% of the control sows and 2-20% of the silage sows, respectively. In the control groups, the more serious vulva lesions decreased slightly during pregnancy. In the silage groups, the occurrence at the first three occasions of observation was at a low level but increased slightly at the fourth observation. However, this difference is probably not a treatment effect but is rather explained by differences in group size, age distribution within the groups and/or the function of an individual feeding station. See Figure 7 for an example of a vulva bite receiving a score 3

Figure 7. A picture of a sow with a severe vulva bite.

Vulva biting is typically seen when sows line up for access to a resource (e.g. for access to feed). In the present study, 21-35% of the sows (both groups and across screening days) were scored with some degree of damage to their vulva. This is in accordance with previous findings (Olsson et al., 2011), showing, that vulva biting is a welfare problem when pregnant sows are housed in large groups in an ESF-system. By providing sows with access to hay silage the queuing at the entrance to the ESF, and hence the occurrence of vulva biting, was expected to be decreased. However, this hypothesis could not be confirmed. The amount of hay silage provided in the present study was rather small (<300 per sow) and likely did not reduce the sow's motivation to seek feed at the ESF. Also, these limited amounts of silage may have been consumed rather quickly and therefore only have affected queuing (and thus the risk of vulva biting) for a short duration after silage was provided. Lastly, the location of the hay racks with silage were located only about 2 sow lengths from the ESF-entrance. Thus, this short distance may not have been enough to distribute the queuing sows within the pen and affect the risk of vulva biting.

Likewise, the registrations of lameness did not show any differences between the silage and control groups, at least not in favour of the silage treatment, which was one of the sub-hypotheses of the study. Therefore, the recordings of lameness in the two groups (control and silage) have been merged to illustrate the general development of lameness during the time in the ESF system. Additionally, scores 0 and 1 have been merged into "no lameness" and scores 2 and 3 into "lameness".

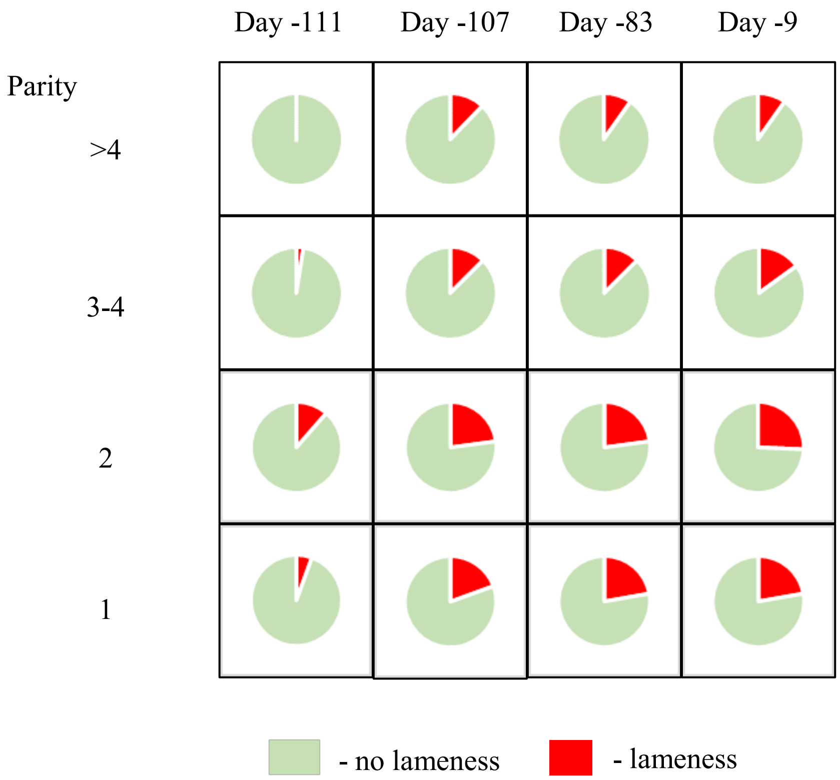

Figure 8. Results from the lameness recordings in the focal animals at the four observation occasions.

The distribution between "no lameness" and "lameness" in the focal animals at the various the observation occasions, is presented in Figure 8. The figure shows that the recordings of lameness were at their lowest at the first observation and that the younger animals were more often recorded as being lame than the older animals. It is also worth noting that the reported results are based on the focal animals that were not removed from the groups due to serious leg problems and lameness. Leg and claw injuries might occur when sows slip during rank order fights or fights in other competitive situations, especially when the floor is hard and slippery. Therefore, it is surprising to note that the lowest number of leg problems was recorded at the first observation when the sows were mixed after weaning and the rank order in the group was established. One explanation might be that the insemination pen is equipped with deep litter and closable individual feeding stalls, which enable the sows to fight without slipping and to lock themselves in, in a feeding stall, when they want to hide from aggressions.

Generally, it was stated that recordings of lameness and leg problems in large groups of sows are a challenge since the animals sometimes do not want to get up or move any longer distances from a “safe” lying area in the pen. This might also be a problem during the daily inspection of the animals.

Recordings of back fat in focal animals

Back fat measurements (by ultra sonic equipment) (Table 3) and registrations of body condition score (BCS) were performed on 48 control sows and 66 silage sows. The lower number of animals observed, compared to the clinical observations on the focal animals, is due to the fact that ultra sonic measurements were not performed in the first experimental control and silage groups, respectively.

Table 3. Recordings of back fat (mm). Values are shown as averages with min-max in brackets

	Control	Silage
No. of animals	48	66
Screening, day -111		
- back fat, mm	14,6 (8-23)	14,9 (7-24)
Screening, day -83		
- back fat, mm	16,9 (10-23)	17,0 (8-26)
Screening, day -9		
- back fat, mm	19,5 (10-28)	18,5 (10-28)

The back fat measurements of the focal sows showed higher values (Table 3) than recommended by Topig's Norsvin. According to Topigs Norsvin (2015) recommendations are a minimum of 14 mm and a maximum of 16 mm back fat before farrowing. The measurements also showed a relatively large variation between the sows. Prior to farrowing, 20 sows (42%) in the control groups and 25 sows (38%) in the silage groups had a back fat over 20 mm. According to Gård & Djurhälsan (Hallgren and Eriksson, 2020; Mattsson, 2014), sows with a back fat over 20 mm are judged to be “fat”. The visual scoring of BCS was moderately correlated with the back fat measurements ($r=0,55-0,60$; p-value $<0,001$).

Although silage was given as "extra feed", this extra provision did not seem to increase the back fat nor BCS. The explanation is probably again that the provided silage amounts were small.

Conclusions

The present study supports the existing findings, that vulva biting is a welfare problem, when sows are housed in an ESF-unit. Aggression did occur and the level of aggression, as reflected by the level of skin lesions, appeared to decrease over time in the higher parity sows but not in the younger sows. Accordingly, both Arey (1999) and O'Connell et al., (2003) suggested that in particular the welfare of low ranking animals (which are most often the younger animals) may be challenged (e.g. have more injuries and be positioned lower in the feeding order) in high competition housing systems such as the ESF-system.

Contrary to the expected, provision with hay silage had no significant effects on any of the recorded variables. A reason for this may be the low amounts of silage provided. When providing sows with access to grass silage, O'Connell (2007) found that sows consumed an average of 1.8 kg daily, which is far from the <300 g/sow/day provided in the present study. Thus, the small amounts may not have been enough to affect the satiety level of the animals or occupy them to a level affecting the group dynamic in the pen. Furthermore, the sows only had access to two hay racks per ESF pen, which were located relatively close to each other and only two sow lengths from the entrance of the feeding station.

Future studies should consider using larger amounts of hay silage and consider providing better access to this resource to avoid the risk of simply creating another limited resource in the pen. In the present study the two hay racks were placed in an area with solid concrete, intended as a lying area. Even a solid lying area can be considered as a limited resource at the minimum dimensions that apply to ESF systems.

The results from the measurements of back fat showed a relatively large proportion of fat sows. The reason for this is unclear, but may be explained by the fact that the amount of feed delivered by the feed stations were not correctly calibrated. Constant calibration of the feed stations is important for an optimal operation.

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