Farrowing pen size and maternal behaviour of organic sows

Report on POWER activity 2.7

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Summary

Larger organic farrowing pens with more opportunities to perform nest building and maternal behaviour are a potential way for better care for the piglets. Behaviour and performance of 60 sows and litters was studied on a commercial organic pig farm during 1.5 years in farrowing pens of 8 or 24 m². Video footage was recorded from 24 h before birth of the first piglet until 72 h after birth of the last piglet. Activity and postural changes of the sows, piglets and position of the nest were scored by scan sampling. The results showed more nest building behaviour and lower piglet mortality in larger pens, but without a difference in prepartum activity or risky postural changes postpartum. This outcome suggests that it might be beneficial to provide organic sows more space around farrowing.

This report can be downloaded for free at https://orgprints.org/view/projects/POWER.html .

Public Wageningen Livestock Research Report

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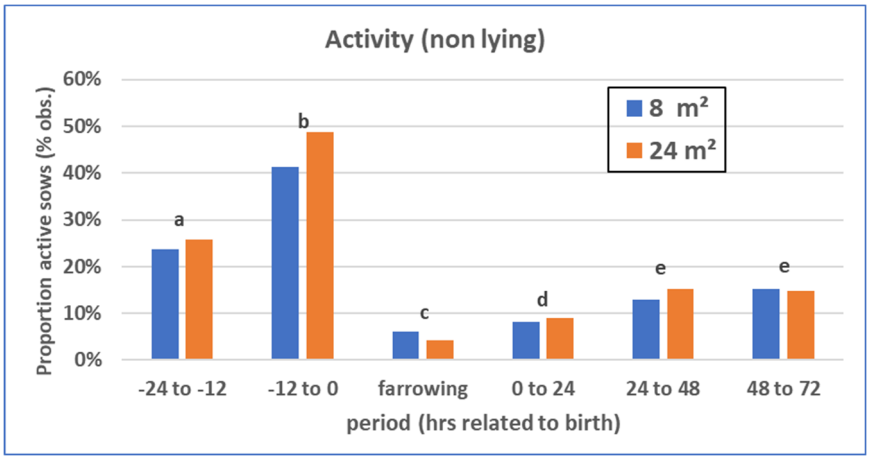
Summary

Growing litter sizes with lower birth weights lead to more vulnerable newborn organic piglets. Combined with the free movement of the sow around parturition the risk of piglet mortality increases. A larger farrowing pen with more opportunities to perform nest building and maternal behaviour is a potential way for better care for the piglets. In this project we compared farrowing pens of 8 and 24 m² in order to improve natural behaviour (welfare) and survival of newborn piglets (welfare and economy).
Behaviour and performance of 60 sows and litters was studied on a commercial organic pig farm during 1.5 years. Video footage was recorded from 24 h before birth of the first piglet until 72 h after birth of the last piglet. Activity and postural changes of the sows, piglets and position of the nest were scored by scan sampling. Performance data was recorded by the pig farmer on a score sheet per sow.

As expected the sows showed and increased activity during the 12 h pre farrowing, but without any difference between the two pen sizes (see figure). However a qualitative assessment showed more sows with nest building behaviour (collecting straw) in the large pens. Risky body movements of the sow are a risk factor for piglet mortality (crushing). These postural changes did not differ between the two treatments. The piglet mortality was 7% lower in the larger pens (20 vs 13%; p=0.04), resulting in 10.1 vs 11.1 weaned piglets.

Figure. Proportion of activity per treatment per period around farrowing (no differences between treatments; differences between periods indicated by different superscripts)



The results show more nest building behaviour and lower piglet mortality in larger pens, but without a difference in prepartum activity or risky postural changes postpartum. This outcome suggests that it might be beneficial to provide organic sows more space around farrowing.

A detailed dose-response study is necessary to find the best balance between on one hand promoting sow nest building, maternal care behaviour, colostrum intake and piglet comfort and on the other hand developing economic competitive systems.

1 Introduction

Around farrowing organic sows are not confined in a crate. However crates were developed in the 20th century pig husbandry to protect the piglets against the risk of being crushed by their mother and economically viable. With anti-crushing bars organic pig farmers try to minimize this crushing risk. However the 7.5 m² legally required indoor space is reduced by piglet nest, trough, anti-crushing bars and partly slatted floor without bedding. The question is if this leaves sufficient solid and bedded surface for nest building and careful lying down of the sow. At least a turning circle is necessary for the sow to perform these behaviours. An adult sow has a body length of 2 m, so a turning circle should also have a diameter of at least 2 m (3.14 m²). This is why organic farrowing sows show more maternal behaviour than conventional ones (Wallenbeck et al., 2009). The challenge has always been to create an optimal environment for the sow, the piglets and the pig farmer. So far this inevitably leads to a compromise.
Under natural conditions domesticated pigs build nests after finding a safe location by digging a shallow hole and cover it with various fibrous materials as branches, ferns and grass as reviewed by Baxter et al. (2011). Wischner et al. (2009) wrote in a review about the preferred nest location under natural conditions: on the border of forest and open field, offering shelter, a cover and an open view and often on the downside of a slope. She also states that 24-12 h prefarrowing the focus is on nest seeking behaviour and from 12-6 h prefarrowing is spent on furnishing the nest with branches, grass and ferns. Freedom to move around and to rearrange straw to build in nest is also important in an indoor situation. Nowland et al. (2019) found more maternal behaviour in a free farrowing environment compared to crated farrowing. Free farrowing organic sows with large litters of small fragile newborn piglets need optimal farrowing conditions (Vermeer et al., 2021). The risk on piglet mortality increases if one or more of these conditions are suboptimal (Prunier et al., 2013).

Activity 2.7 within the EU project POWER focused on the effect of additional space in organic farrowing pens on maternal behaviour of the sow and the neonatal piglet mortality. Farrowing pens of 8 m² (7.5 m² is the standard for organic sows) was compared with 24 m² pens. This was indoor space, the outdoor space was similar in both treatments and measured approximately 7 m² per sow. The observations focused on 24 h before farrowing until 72 h post farrowing and in particular on sow behaviour and piglet survival.

1.1 Objective

The aim of the project was to stimulate natural behaviour (nest building and maternal behaviour) of the sow and survival of the newborn piglets by offering a larger indoor space in the farrowing pen.

2 Material and Methods

The experiment was carried out from November 2018 to December 2020 on a commercial organic pig farm with a herd of 55 sows of the TopigsNorsvin20 genotype. These sows farrow almost twice a year, so about 100 litters were planned. That was an average of 4 litters every two weeks.
The sows were moved to a farrowing pen a few days before the expected date of farrowing. They received about 20 kg of straw on the solid floor in the indoor area. Fresh air was provided by a natural ventilation system. The rooms were not heated, except a heating lamp in the piglet nest. Around farrowing lights were switched on continuously. Via a buffer area with a drinker they got access to an outdoor run. This outdoor run had a partly slatted floor and was not covered by a roof.

2.1 Treatments

Treatments
In the experiment we compared two treatments with one sow per pen (see figure 1):
Small pen (A=Control): This treatment was comparable to the most common organic farrowing conditions on commercial farms. The indoor area measured 1.65 m x 5.0 m (8 m²), a buffer space 1.65 x 1.50 m and the outdoor run 1.65 x 2.80 m with a 0.80 m wide slatted part on side of the building.
Large pen (B): The indoor area measured 3.30 m x 7.30 m (24 m²), a buffer space 3.30 x 1.50 m and the outdoor run 3.30 x 2.80 m with a similar slatted part as in the small pens.
The highly pregnant sows that were not housed in one of the treatments farrowed in the standard farm system, that was two sows together in a large pen. The sows were fed manually on the floor twice a day. Water was available from a nipple drinker in the buffer space.

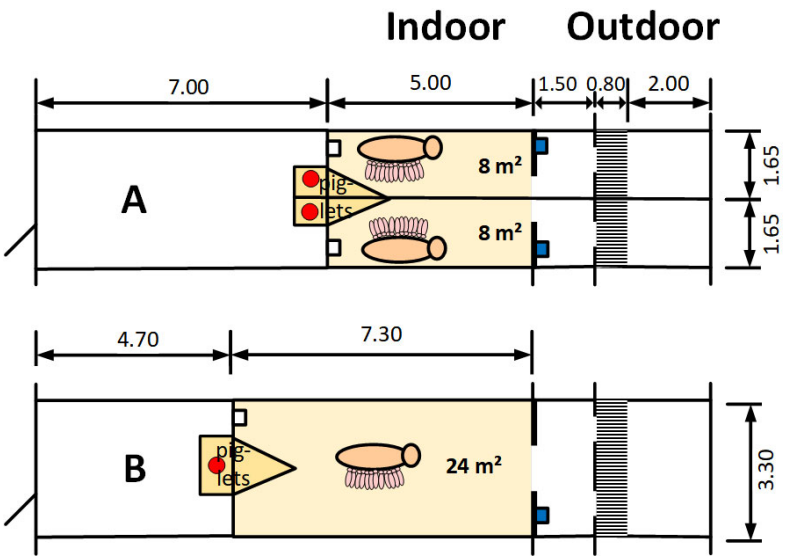


Figure 1: Layout of two experimental rooms with small pens (A) and with a large pen (B). In the indoor area only the coloured part is accessible by the pigs.

2.2 Data collection

2.2.1 Behaviour

Above each pen a colour camera (TopView IPC3634ER3-DPZ28 mini dome) is installed in order to record video footage continuously. Later we selected and stored videos from 24 hours before

farrowing until 72 hours after farrowing. At night the cameras switched to black and white with infrared light. According to the observation protocol, behavioural observations are performed during 1) 24 hours pre farrowing (birth first piglet), 2) during farrowing and 3) 72 hours post farrowing (birth last piglet). The required video footage is recorded on one of the two Digital Video Recorders (TopView NVR301-08-P8) and monthly exchanged with the second Digital Video Recorder and the video footage copied to a share of the Wageningen University & Research network in the week after the exchange of the Digital Video Recorder. We selected the required time period after determining the birth of the first and last piglet. The treatment per sow was decided on a random basis in close cooperation with the farmer.

Protocol behavioural observations from video

From the video recordings (24 h pre farrowing – farrowing - 72 h post farrowing) we extracted images with respectively 5-3-10 min intervals. With a MatLab code, activity (lying-standing), position (head direction), posture (left-right), nest position and location of the piglets were scored from all these images. We scored the nest building behaviour qualitatively from the pre-farrowing video recordings on a scale from 0 (no nest building), 1 (partly nest building) and 2 (complete nest building). Nest building was regarded as collecting straw on a specific spot in the pen. The screenshots show two examples of a sow in a large and a conventional farrowing pen. Details are described in Appendix 1.

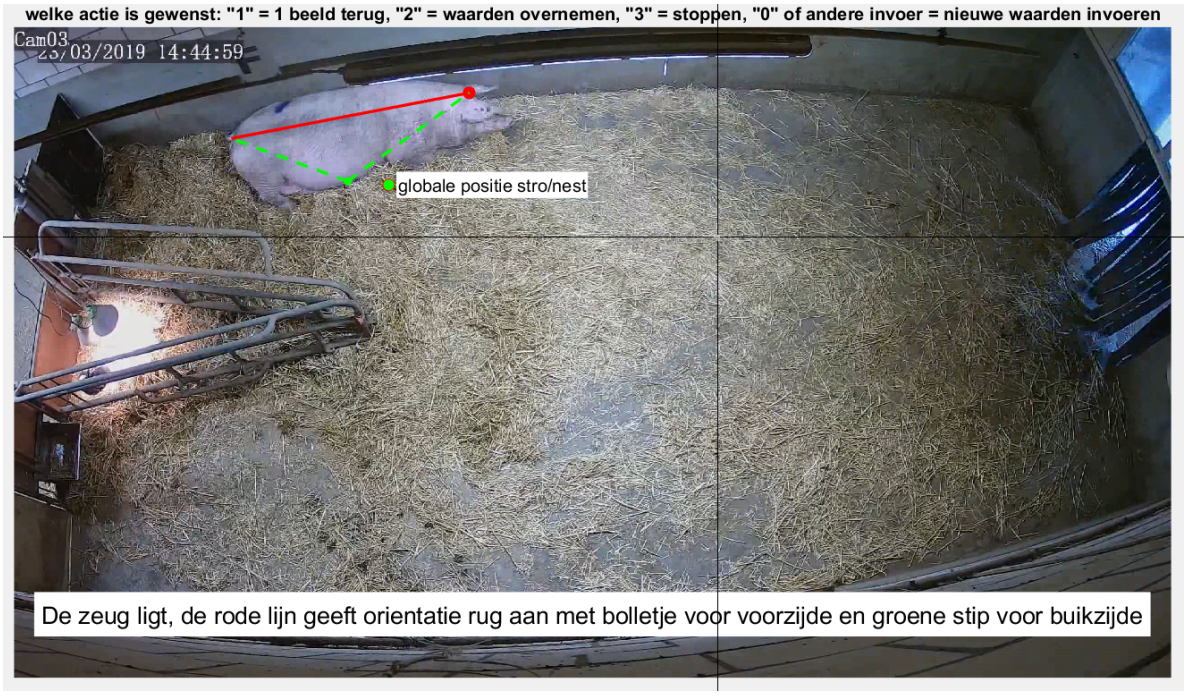


Figure 2. Screenshot of a large pen with a sow before farrowing, the red line connects the head and the tail of the sow, the green line the position of the udder; the green dot indicates the position of the nest.

2.2.2 Performance

The estimated time of farrowing is recorded per litter, the number of live and stillborn piglets and the number, time and cause of the piglets that died all recorded by the pig farmer. The number of piglets is also recorded at weaning. A recording sheet is available per pen, which can also be used by the pig farmer as a logbook for details (Appendix 2).

2.2.3 Dunging pattern

Dunging pattern (indoor and outdoor) was recorded every two weeks by the research assistant on a paper score sheet. These visits to the farm took place every 14 days shortly before the average calculated farrowing date.
The floor plan of the pens was divided in squares by a grid of 4 or 9 (small and large resp.) and scored on a paper sheet. Scores were based on the proportion of dirty and wet surface of the floor, on a scale from 0 (clean) to 5 (completely dirty). The grid per pen type and the score sheet can be found in Appendix 3.

Figure 3. Screenshot of a sow in a small pen

2.3 Data analysis

Each born litter is an experimental unit within this project, so all results will be analysed on litter level. All variables will be analysed with Analysis of Variance with the statistical model $Y = \mu + \text{treatment} + \text{litter-size} + \text{parity} + \text{season} + e$. The statistical package used was Genstat 19.1 (VSN International Ltd., 2018). If necessary variables were log-transformed to create a normal distribution.

Behaviour
Activity (lying-standing), posture changes and piglet in the piglet nest were analysed with data of all 60 litters. All three behaviours were log-transformed. Production phase (pre-post farrowing) and the interaction between pen size and production phase were included in the model.

Performance
Farrowing duration and number of died piglets were log-transformed and analysed with litter size as covariate and parity as treatment. Stillborn piglets was log-transformed and analysed with log-total born as covariate and parity as treatment. Total born piglets were analysed with parity as covariate. Litter size was analysed with parity as treatment and total born as covariate.

Dunging pattern
The indoor pen fouling scores were log-transformed and analysed with analysis of variance and REML to estimate the effects of season and days after farrowing, which were included in the model as covariates. The scores of the buffer and the outdoor area were analysed in a model with an ordinal scale (procedure IRCLASS), because there was only one score per area.

3 Results

We collected data from 60 litters, with 29 in the small and 31 in the large pens. Sows with incomplete video recordings were not included in the data set. Unfortunately it was not always possible to recover all sow related data from the farmer's administration and a digital management information system was absent.

3.1 Behaviour

The sows in both treatments showed an activity pattern as expected: Very active in the last twelve hours before birth of the first piglet, inactive around farrowing and then gradually increasing, without difference between the two pen sizes (Fig 4). We scored the nest building behaviour qualitatively from the pre-farrowing video recordings and in the small pens this behaviour was lower than in the large pens. (resp. 3 full and 2 half versus 5 full and 9 half nests) (Table 1). The number of postural changes decreased strongly from the start of farrowing and did not differ between the treatments (Fig 5). The proportion of piglets in the nest was low and increased only slightly in the first days after birth (Fig 6).

Table 1.

	8 m^2	24 m^2	Significance
Farrowing duration (h:mm)	3:25	3:15	NS (p=0.597)
Activity (% obs)	14.60	14.90	NS (p=0.390)
Postural changes (% obs)	18.92	19.61	NS (p=0.378)
Piglets in nest (% obs)	3.01	3.29	NS (p=0.543)
Nest building (N no/half/full)	24/2/3	17/9/5	too small to test

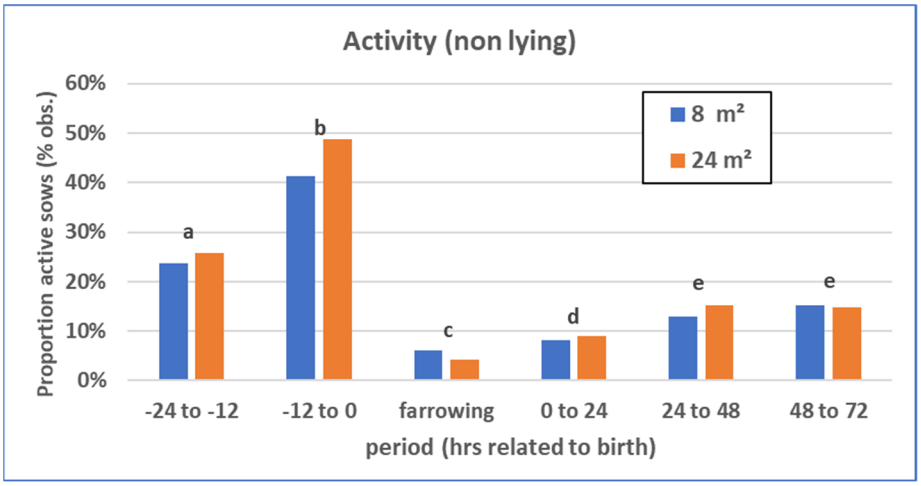


Figure 4. Activity of sows per period per treatment (different superscripts indicate P<0.05 for periods)

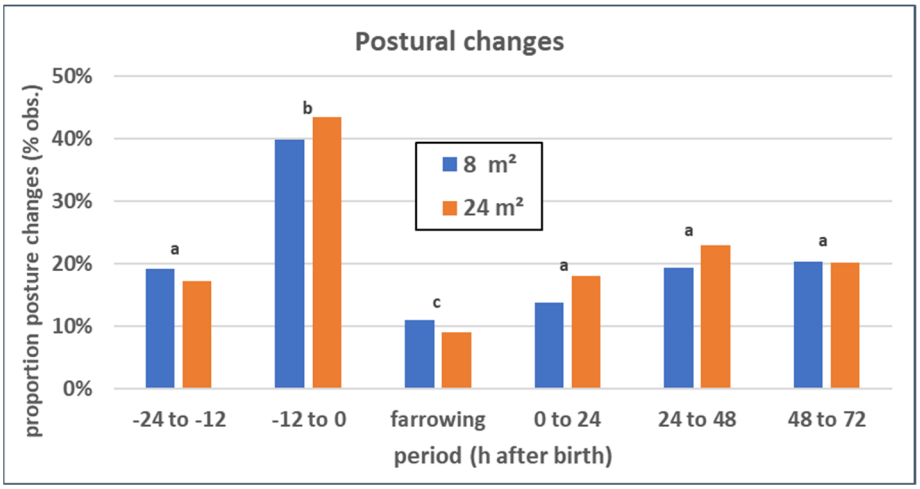


Figure 5. Postural changes of sows per period per treatment

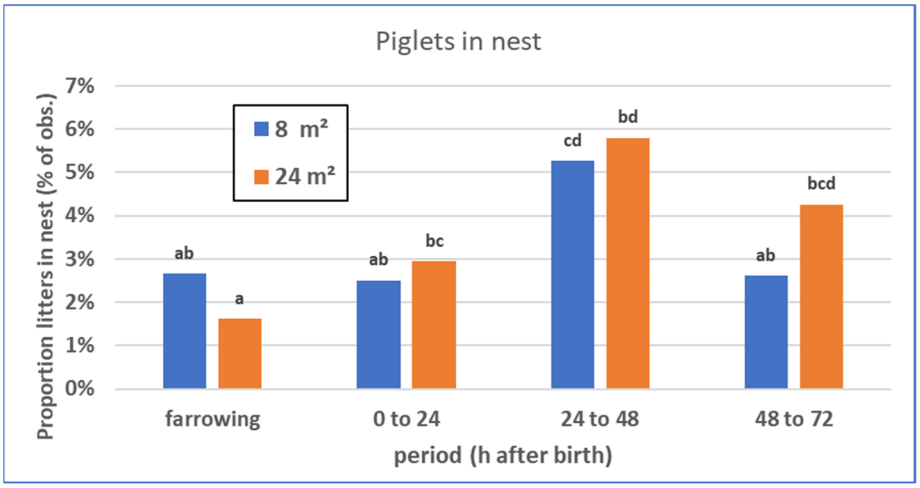


Figure 6. Piglets in piglet nest per period per treatment

3.2 Performance

We had a complete dataset of only 42 litters that could be used for the statistical analysis, due to incomplete registrations. The average parity was similar as were the number of total born and the number of live born piglets per litter in the two treatments. The mortality was higher in the small pens (t=0.041), so in the large pens the number dead piglets was 0.8 higher than in the small pens. The cause of death was crushing in 53% and 55% of the cases in 8m² and 24m² respectively.

Table 2. Average litter size and mortality per treatment.

	8 m²	24 m²	Significance
Number of litters	29	31	
Total born	14.55	14.11	NS (p=0.613)
Liveborn	13.34	13.58	NS (p=0.529)
Mortality (%), (backtransformed)	21% (18.8%)	18% (11.9%)	Signif (t=0.041)

3.3 Dunging pattern

The dunging pattern was recorded during every visit and showed the general pattern that the pens were clean in the front where the lying area, feeding area and piglet nest were located. The buffer area with drinker and solid floor between indoor and outdoor was the dirtiest area. In the analysis the front areas of the grid were compared the other areas in the back of the pen, the buffer area and the outdoor area. Litter, age of the piglets and season were included in the model. Pen size was never significantly different, but there was a significant effect of season and age of the piglets.

Table 3. Pen fouling score (0-5) per treatment and per pen area.

	8 m^2	24 m^2	Significance
Indoor front	0.31	0.27	NS (p=0.530)
Indoor back	1.37	1.15	NS (p=0.441)
Indoor average	0.97	0.92	NS (p=0.806)
Buffer	4.14	4.74	NS (F=0.774)
Outdoor	3.10	3.28	NS (F=0.662)

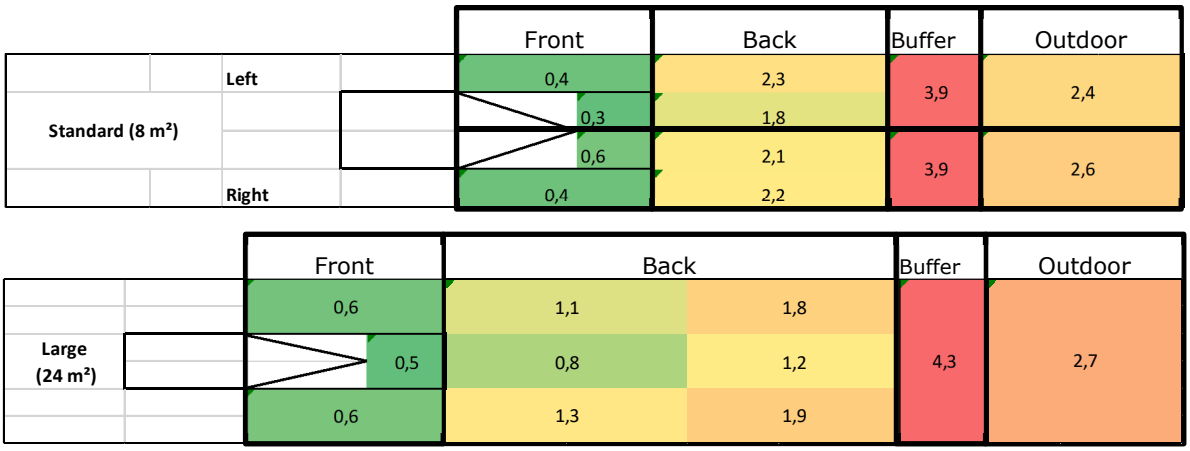


Figure 7. Average pen fouling score per pen area (each area scored from 0 (clean) to 5 (dirty)), for 2 small pens (upper drawing) and the average large pen (lower drawing).

4 Discussion and Conclusions

The difference in farrowing pen size didn't show remarkable differences in behaviour. Activity and postural changes pre and post farrowing didn't differ. Qualitative scoring of nest building behaviour tended to be higher in the large pens and that could be an explanation of the higher survival rate of the piglets in these larger pens.

Nest building behaviour of sows under natural conditions (outdoor) is very much comparable with that of indoor kept sows (Algers and Uvnäs-Moberg, 2007). It peaks around 8 h prefarrowing and then rapidly decreases. In most indoor organic farrowing pens 1-1.5 m² is used for the piglet creep, a dunging area measures between 0 (absent) and 3 m², leaving 3-6 m² solid floor as bedded lying area. Seeking a nest site and nest building behaviour require at least a turning cycle with the length of the sow as diameter. Such a circle would fit in a square of minimally 2x2, but preferably 3x3 m, which is mostly not available in organic farrowing situations. The large pens in this experiment had a width of 3.30 m and 7 m deep, whereas the small pens were 1.65 m wide and 5 m deep. So the small pens were too narrow to perform proper nest building and maternal behaviour. According to Wischner et al. (2009) the large pens fulfilled most of the pigs' needs: safe, ability to turn around, substrate and view.

The farrowing duration was similar for the two treatments and with 3 h 20 m, similar to Nowland et al. (2019), but much less than the 7 h 30 m found by Kobek Thorsen (2017) in outdoor huts. This could be an indication that the sows felt at ease in the farrowing accommodation. Generally a short farrowing duration is positive for piglet vitality and survival rate. We also found no difference in litter size, so the starting position of the newborn piglets was similar.

Clear nest building behaviour was more visible in the large pens, however in the smaller pens there was not much to chose for a nest site. Most of the nesting behaviour was backwards scraping the straw with the front legs to a central location. Carrying straw in the mouth was rare, although it was relatively long straw (10-30 cm). The mortality was significantly lower in the large pens, unfortunately there is no clear explanation. So with these numbers per treatment, we must therefore be careful in drawing firm conclusions.

Baxter et al. (2011) described the continuous search for the compromise between piglet needs, sow need and farmer income and labour conditions. More freedom in a large farrowing pen is more costly than a standard organic farrowing pen, and will not be outweighed by more benefits from a better performance. However, the large pen isn't necessary for the whole lactation. Sows and litters could be moved to smaller, cheaper pens or to a group suckling pen. The large expensive pens are probably only necessary during the first 7-10 days after farrowing according to the needs of sow and piglets, summing up to an occupation of 2 weeks.

The organic EU regulations stipulate a minimum pen size of 7.5 m2 per lactating sow with a mandatory addition of 2.5 m2 outdoors. POWER findings indicate that more space is needed when extending the lactation to promote piglet health at weaning and further that very large pen sizes (24 m2 per sow) are beneficial in terms of improving piglet survival. Detailed dose-response studies are needed to find the best balance between on one hand promoting sow nest building, maternal care behaviour, colostrum intake and piglet comfort and on the other hand developing economic competitive systems.

Regarding the size of the farrowing pen, considering the upcoming evolution of European welfare regulations for conventional sows, and considering our results showing that pens bigger than the current organic rule (7.5 m²) are beneficial for animal welfare, performance and pen fouling. Organic farrowing pens larger than 7.5 m² could help to maintain a welfare difference with conventional production.

4.1 Conclusions

- No differences in activity and posture changes around farrowing between large and small pens
- Lower piglet mortality in the large pens
- Tendency for more nest building in large pens

4.2 Practical implications

The present organic sows with their large litters seem to benefit from larger farrowing pens. The size used in this experiment might be too expensive, but an increase from the current 7.5-8 m² to a pen with some more space to move around can provide the sows some more nest building opportunities and space to avoid crushing her piglets. After the first week the sow and litter could be moved to a smaller pen or to a group pen to make it economically feasible. A dose-response experiment could be helpful to determine the optimal size of a larger farrowing pen.

5 Acknowledgements

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Appendix 1 Data handling video-observations

Video images were almost continuously recorded from March 2019 to December 2020 on a distant commercial organic pig farm and collected them every 14 days by exchanging 2 digital video recorders (DVR). The video footage was downloaded from the DVR at the office in Wageningen. The standard procedure on the farm was to house couples of sows in a large pen. For the duration of the experiment part of the sows was single housed in small or large pens. Firstly we selected sows housed alone in a small or a large pen and searched for birth of first and last piglet. Video images of 24 h before the birth of first piglet until 72 h after birth of the last piglet were selected. From this video footage images were selected with 5 minute intervals before farrowing, 3 minute intervals during farrowing and 10 minute intervals after farrowing. Per sow we collected approximately 288 observations (24 h x 12) prefarrowing, between 40 and 100 observations (20/h) during farrowing and 432 (72 h x 6) observations postfarrowing, in total around 780 records per sow. These images were saved in three mp4 files per sow: prefarrow, farrow and postfarrow. The images were analysed visually by two observers with a protocol described in "Observaties kraamzeugen POWER.docx" (subfolder Data\Act 2.5 Farrowing Pen Size). In order to register the observations a Matlab procedure was developed to score positions of the sow, piglets and (straw)nest. These Matlab files were described in "programmabeschrijvingen POWER-project.docx" (subfolder beeldbewerking). The observations were merged into one Excel file with approximately 45.000 records. Sow totals per period were summarized in one Excel file with one record per sow.

With these records we calculated (formulas and drawings in files 2 and 5):

- Position of the middle of the sow (avg of front and back) in the pen; 4 defined areas (82,5 cm x 250 cm) in the 8 m2 pen and 6 areas (110 cm x 260 cm) in the 24 m² pen.
- Lying angle (orientation) (N=0°;E=90°;S=180°;W=270°)
- Distance between "back and udder" (sternal or lateral lying)
- Lying on left or right side
- Activity: lying (1), standing (2, incl sitting) or outside (3) (=not visible)
- Eating defined by standing with position of the head in the area were the feed was provided (60x60cm)
- Position of the (majority of the) piglets and distance to the sow and presence in the nest (creep)
- Position of the largest amount of straw, regarded as the "nest";
- Change of posture was calculated as change from lying left to right, change of front position more than 30 cm (X or Y coordinate)

Appendix 2 Sow sheet

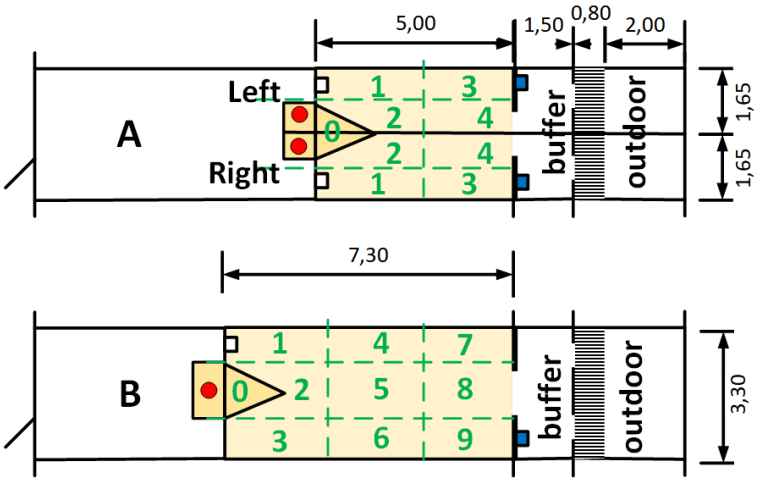
Performance scoring sheet per sow and litter

POWER - Registraties kraamhok

Zeugnr		Worpnummer		Behandeling (8 of 24 m²)	
Afdeling		Hok			
Datum in		Datum werp		Werptijdstip (uur)	
1ste big (video)		Laatste big (video)		Datum zeug uit hok	
min 24 u		plus 72 u		Datum biggen gespeend	
				Datum biggen uit hok	
n levend geboren					
n dood geboren				Datum castratie, liefst > 72 u	
bij/weggelegd					
datum overleggen					
datum uitval 1		Reden uitval 1			
datum uitval 2		Reden uitval 2			
datum uitval 3		Reden uitval 3			
datum uitval 4		Reden uitval 4			
datum uitval 5		Reden uitval 5			
datum uitval 6		Reden uitval 6			
Behandeling zeug		Behandeling biggen		Opmerkingen	

Appendix 3 Pen fouling score sheet

Pen fouling score sheet per room, pen and date and area



			Bevuilingsscores										
Afdeling	L/R	datum	1	2	3	4	5	6	7	8	9	tussen	buiten