TEST OF DIFFERENT SUPPLEMENTARY AIR INLETS IN A FARROWING HOUSE

REPORT NO. 1603

Tests made in a farrowing house during the summer reveal that supplementary air inlets improve sows' immediate environment.

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Abstract

SEGES Pig Research Centre tested three different types of supplementary air inlets in a farrowing house to evaluate the effect on the sows' immediate environment during the summer. The three different types included trough valves, a single ceiling inlet per sow and transverse ceiling inlets in the section. No supplementary air inlets were installed in the control section. The primary parameters included temperature and CO_2 concentrations recorded down in the pen, and each group comprised two farrowing pens.

Data revealed that it was possible to lower the temperature as well as the CO_2 concentration with supplementary air inlets during the summer compared with the control group with no supplementary air inlets. The lowest temperatures in the pens were recorded in the groups with trough valve and one ceiling inlet per sow, respectively. In the group with transverse ceiling inlets in the farrowing house, the temperatures recorded in the pen were level with the temperatures recorded in the control group. The carbon dioxide concentration recorded in the pen was lower in all three groups with supplementary air inlets than in the control group. The temperature in the farrowing house was also lower in the three sections with supplementary air inlets, which was attributed to an increased air intake in these groups.

These results demonstrate that supplementary air inlets have a positive effect on sows' immediate environment and that the location of these affects the immediate environment when they are open. Analyses revealed no significant differences between the groups in sows' lying behaviour and pen hygiene.

In the period without supplementary air inlets, data show a significant difference in the temperature down in the pen in the group with trough valves compared with the remaining groups. The lower temperature recorded in the pens with trough valve was attributed to the release of a small amount of air despite the fact that the damper in the ceiling was shut.

On the basis of these results, it is our conclusion that supplementary air inlets in warm weather improve the immediate environment of the sow as the highest temperatures and the highest CO_2 concentrations in the pens were recorded in the control group with no supplementary air inlets. The optimum environment for the sows was obtained with one ceiling inlet per sow.

Background

In pig houses with diffuse ventilation, additional cooling options, such as sprinkling or supplementary air inlets, may be necessary in warm weather (summer).

The thermal comfort of piglets and sows must be fulfilled by the climate in the farrowing pen. Sows' thermal comfort zone ranges between 14 and 20 °C [1] and their upper critical thermal zone ranges between 22-28 °C, while for piglets the optimum temperature is 30-34 °C [1]. In warm weather, establishment of additional cooling, such as air inlets, may become necessary. If a sow is too hot, its appetite may drop, which will consequently lead to a drop in milk production. Increased fouling is also often observed, probably as the sow spills water on the pen floor in an attempt to cool down.

To improve the environment of sow as well as piglets, supplementary air inlets in the form of ceiling inlets placed above the sow or in either side of the section are often used. In Brazil, where temperatures soar during the summer, trough valves are often used, which is a pipe placed close to the head of the sow that directs the air towards the head of the sow at an air speed of roughly 2.0 m/s [2]. Similar examples are seen in the Netherlands where, instead of additional ceiling inlets, a pipe is placed directly above the sow's head leading the inlet air directly towards the sow. In Denmark, we also see examples of tubes installed above the sow's head, but without any management of the air speed or of how many m^3/hour air is directed towards the sow.

The aim of this trial was to assess the ventilation impact of using different types of supplementary air inlets in farrowing houses including one ceiling inlet per sow, transverse ceiling inlets in the section and trough valves. The effect was recorded during the summer.

Materials and method

Farrowing house: design and production

The trial was conducted in one herd with 650 sows and production of 7 kg pigs; four sections (A-D) were included in the trial. The herd is run in five-week-cycles with one-week-intervals between the four sections. The aim was a litter size of 14 piglets after crossfostering. Recordings were made during the summer in the period July 3 to September 21.

The sections were designed with four rows of nine farrowing pens each (produced by manufacturer Sdr. Vissing), totaling 36 farrowing pens per section. The sows were crated during lactation. The pens measured 2.7 m x 1.75 m with 1.5 m solid floor and the remaining floor was slatted (cast iron slats). Post-farrowing, 100 W heat lamps were on the first days, and the floor of the creep area was heated. The sows were fed dry feed three times a day (7:00; 15:00 and 19:00) and straw was provided as rooting and enrichment material.

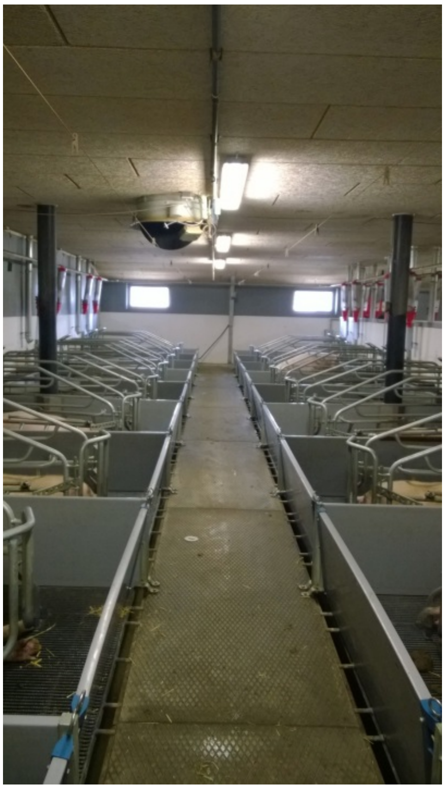

Figure 1. Trial section with supplementary air inlets in the form of trough valves.

Description of ventilation and supplementary air inlets

The farrowing house is ventilated via diffuse air intake through the ceiling via 2 x 50 mm mineral wool and 25 mm wood concrete board. The ventilation system is from SKOV A/S and designed with a DA600 ventilator mounted in the ceiling in each section.

The ventilation system in each section was controlled by a DOL234 ventilation control from SKOV A/S. Section A constituted control with no supplementary air inlets during the trial period and in sections B-D supplementary air inlets were operated as shown in Table 1. The ceiling inlets used in section C were DA 1211B models from SKOV A/S with a maximum capacity of 1,000 m^3/hour at a negative pressure of 10 Pa. In section D the ceiling inlets were of the model DA 1500 from SKOV A/S with a maximum capacity of 1,400 m^3/hour at a negative pressure of 10 Pa.

Table 1. Outline of supplementary air inlets in the three trial sections. Section A = control (no supplementary air inlets were operated during the trial).

Section B	Section C	Section D
Trough valve	A single ceiling inlet per sow (DA 1211B)	Transverse ceiling inlets in the section (DA 1500)
		

The trough valve used in section B consisted of a pipe with a diameter of 96 mm (inside measurement). In the attic, two connection wells were installed from which 18 tubes directed the air to the trough valves in each of the two rows of farrowing pens. Each well had a capacity of 600 m^3/hour corresponding to 33 m^3/hour/sow via the trough valves when the ventilation system operated at full capacity. The trough valve was mounted above the trough as shown in Table 1.

Table 2 provides an outline of the temperature strategy for activation of the supplementary air inlets depending on the outdoor temperature. This temperature strategy is based on a previous trial with supplementary air inlets and solid floor [3] and is adapted to match the age of the piglets.

Table 2. Activation of ceiling inlets depending on outdoor temperature and week of production in the farrowing house.

Week of production	1	2	3	4	5
Outdoor temperature, °C	22	19	19	19	19

Recordings

The primary recording parameters for assessment of the sows' immediate environment included temperature and carbon dioxide concentrations (CO_2). Secondary parameters included ventilation output, number of sows, fouling on the solid floor and sows' lying behaviour.

Temperature and carbon dioxide

For this trial, recording equipment (temperature and CO_2) was installed in two farrowing pens in each section on the same spot in the section. The air speed varied slightly in the trough valve as the tubes from the wells in the attic varied in length. Prior to trial start, the air speed was recorded in all trough valves. The two trial pens were selected on the basis of the air speed recorded and with a target air speed of 2.0 m/s. The two trial pens were pen number five in rows 1 and 2, respectively. Carbon dioxide and temperature sensors were placed on the crate near the sow's head (see Figure 2).

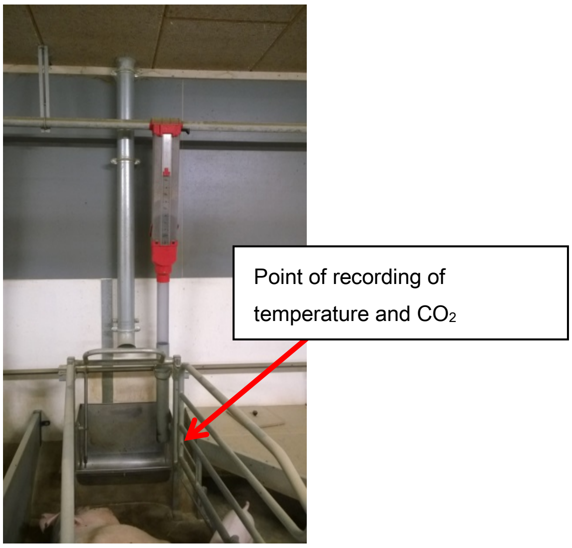

Figure 2. Location of temperature and CO_2 sensors. The sensors the placed at the end of an iron tube to protect sensors and wires.

The carbon dioxide concentrations were recorded in the trial pens in each of the four sections using a VE18 MultiSensor from VengSystem A/S. At each point of recording, pumps would pump approximately 0.6-1.2 litre of air/minute via Teflon™ tubes to the VE18 MultiSensor. A valve block alternated every ten minutes between each pump and every other time outdoor air was led through the recording system of the VE18 MultiSensor. The air in the valve block was preheated to 34 °C before it was pumped into the measurement instrument. Carbon dioxide concentrations were recorded just before switching recording points using a Vaisala sensor with a recording range of 100-5,000 ppm.

Every five minutes, the outdoor temperature, the temperature in the pig house and the temperature down in the pens were recorded using a VE10 Temperature Sensor from VengSystem A/S.

Ventilation output

The ventilation output was recorded electronically every five minutes with Dynamic Air on each of the suction units. The position (open/shut) of the ceiling inlets was also recorded electronically.

Lying behaviour and fouling on the solid floor

Three times a week, staff recorded the sows' lying behaviour, including the number of sows, in all 36 pens in each of the four sections. Recordings distinguish between lateral position, prone position or standing. The percentage of fouling on the solid floor was also recorded in all farrowing pens.

Statistics

The trial period is divided into two: before August 12, 60% of the data are recorded at an outdoor temperature above 19 °C and after August 12, 15% of the data are recorded at an outdoor temperature above 19 °C. All parametres were subject to analysis in PROC MIXED in SAS where 'day' is random effect with an autoregressive covariance structure. If statistical analyses revealed a general difference between the groups, the groups were tested against control.

Results and discussion

Figures 3 and 4 show the carbon dioxide concentrations and temperature down in the pens in all four groups for each of the two periods (with and without supplementary air inlets). Figure 1 in Appendix provides an outline of the outdoor temperature of the entire trial period.

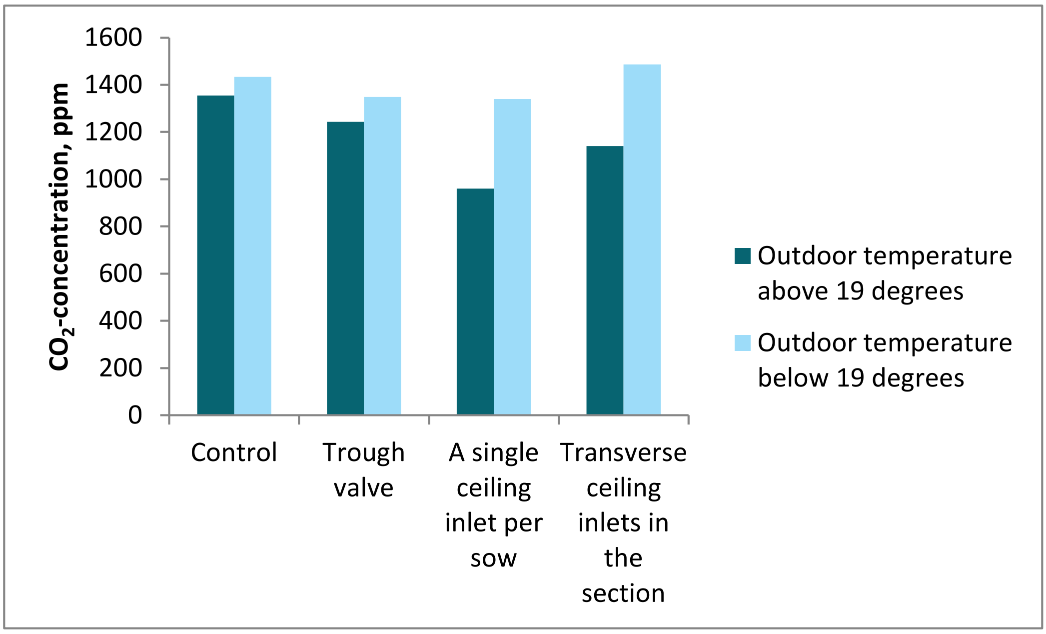

Figure 3. Calculated mean value of CO_2 concentrations in each of the four groups for each period.

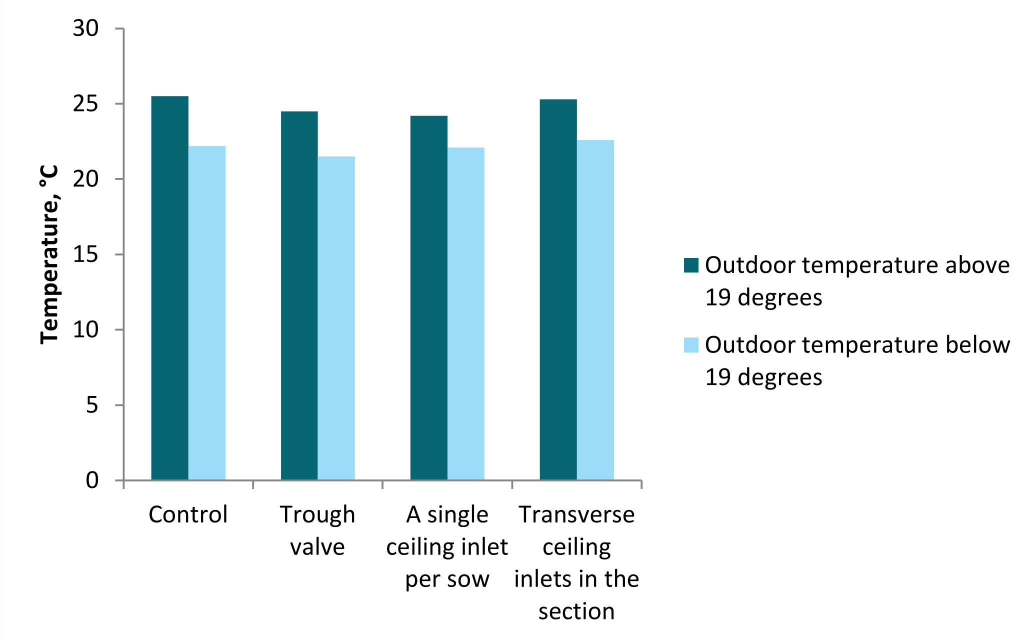

Figure 4. Calculated mean value of the temperature recorded in the pens for each period.

The results are analysed in detail below.

Outdoor temperatures above 19 °C

Data were analysed separately for the period when the temperature over 24 hours rises above 19 °C (supplementary air inlets in operation). In this trial period, the outdoor temperature averaged 20.5 °C. Table 3 shows the results for the summer period.

Table 3. Mean values of temperature and CO_2 recorded in the pens as mean value of the temperature in the farrowing house and ventilation output when trough valves and ceiling inlets were open. A 95% confidence interval is shown in parenthesis. N = days. Ventilation output and the number of sows are calculated for the entire farrowing house, while the remaining values are calculated for two trial pens in each group.

	Control	Trough valve	One ceiling inlet per sow	Transverse ceiling inlets	P value
N	13	14	13	12	-
Temperature down in the pen, °C	25.5[a] (24.8-26.1)	24.5[b] (23.9-25.2)	24.2[b] (23.5-24.8)	25.3[a] (24.7-25.9)	<0.001
CO_2 concentration in the pen, ppm	1,354[a] (1,275-1,432)	1,243[b] (1,166-1,319)	961[b] (882-1,040)	1,141[b] (1,059-1,223)	<0.001
Temperature in the room, °C	24.4[a] (23.6-25.1)	23.7[b] (23.0-24.4)	23.3[b] (22.5-23.9)	23,7[b] (22.9-24.4)	0.002
Ventilation, m^3/hour	11,293 (10,365-12,222)	10,457 (9,557-11,356)	12,105 (11,176-13,034)	11,446 (10,484-12,408)	0.09
Number of sows	36	35	35	34	-

[a] is statistically different from [b]

Analyses of the temperature recorded in the pen, the CO_2 concentrations in the pen and the temperature in the room revealed significant differences between the four groups. The lowest temperatures in the pen were recorded in the groups with trough valve and one ceiling inlet per sow. The temperature recorded in the group with transverse ceiling inlets was level with the control group (no supplementary air inlets). Carbon dioxide concentrations recorded down in the pens and the temperature in the farrowing house were lower in all three trial groups compared with the control group.

Staff reported that the air in the farrowing house felt cooler with one ceiling inlet per sow whereas the air in the section with trough valves felt identical with the air in the control section that felt warm. Analyses of air movements in the sections made prior to trial start clearly revealed that the air moved more locally down to each individual sow when the trough valve and one ceiling inlet per sow were used. Transverse ceiling inlets produced the most uneven distribution of air that ‘fell down’ before the middle of the rows thereby risking slurry ventilation in the farrowing crates located in the middle.

Analyses of lying behaviour and fouling did not reveal any significant differences between the four groups (see Table A1 in Appendix).

Outdoor temperatures below 19 °C

Data were analysed for periods when supplementary air inlets were not required in order to investigate differences between the four groups. Selection was made for outdoor temperatures of 19 °C (24 hour mean) or less. Results are shown in Table 4.

Table 4. Mean values of temperature and CO_2 recorded in the pens as mean value of the temperature in the farrowing house and ventilation output when trough valves and ceiling inlets were open. A 95% confidence interval is shown in parenthesis. N = days. Ventilation output and the number of sows are calculated for the entire farrowing house, while the remaining values are calculated for two trial pens in each group.

	Control	Trough valve	One ceiling inlet per sow	Transverse ceiling inlets	P value
N	16	16	16	17	
Temperature down in the pen, °C	22.2[a] (21.8-22.6)	21.5[b] (21.0-21.9)	22.1[a] (21.6-22.5)	22.6[a] (22.2-23.1)	0.001
CO_2 concentration in the pen, ppm	1,434[a] (1,355-1,513)	1,348[a] (1,269-1,427)	1,340[a] (1,261-1,419)	1,486[a*] (1,409-1,563)	0.007
Temperature in the room, °C	21.3 (20.9-21.8)	20.5 (20.1-20.9)	20.3 (19.9-20.7)	20.5 (20.2-20.9)	0.08
Ventilation, m^3/hour	6,891 (4,163-9,619)	8,453 (5,723-11,184)	8,917 (6,184-11,650)	7,688 (5,009-10,368)	0.72
Number of sows	35	36	36	35	-

[a] is statistically different from [b]

[*]Trial groups do not differ from control

Results demonstrated a significant difference in temperatures recorded in the pens with trough valves in periods when supplementary air inlets were not used. The low temperature in the groups with trough valves was attributed to a small release of air despite the fact that the damper in the ceiling was shut. Results also revealed differences in CO_2 concentrations recorded in the pens: carbon dioxide concentrations were higher in the group with transverse ceiling inlets compared with the two other trial groups. This is probably caused by slightly lower ventilation in this section compared with the other sections.

Results revealed no significant differences in the air output between the four groups and no significant differences in sows' lying behaviour and pen hygiene (see Table A2 in Appendix).

An essential observation made in this trial with regard to the trough valves was the importance of insulating the tubes in the attic and ensure that they are sufficiently tilted to allow condensation to flow from the tubes.

Conclusion

The results of this trial demonstrate that during the summer the lowest temperature in the pens was obtained in the groups with trough valve and one ceiling inlet per sow, respectively. The temperature recorded in the group with transverse ceiling inlets was level with the control group with no supplementary air inlets. The carbon dioxide concentration recorded in the pens was lower in all three trial groups compared with control. The temperature in the farrowing house was also lower in the trial groups than in the control group. These results confirm that supplementary air inlets have a positive impact on the sows' immediate environment, and also show that the location of the supplementary air inlets affects the immediate environment in warm weather. Results revealed no significant differences in sows' lying behaviour and pen hygiene.

In the period with no supplementary air inlets, the temperatures recorded in the pens with trough valves differed significantly. The lower temperature in the groups with trough valves was attributed to a small release of air despite the fact that the damper in the ceiling was shut.

Based on these results, we conclude that supplementary air inlets in warm weather and the location of the air intake improve the immediate environment of the sows.

References

[1] Kyriazakis, I. & C. T. Whittemore (2006): Whittemore's science and practice of pig production. Third edition. Blackwell Publishing.

[2] Lyngbye, M. (2014): Personlig kommentar. Munters A/S.

[3] Jensen, T. L. & A. L. Riis (2012): Demonstration af klimastyring til forbedret stifunktion i slagtesvinestalde med delvist fast gulv. Report no. 1206, Dansk Svineproduktion.

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Trial no. 1349

Activity no.: 053-330100

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Appendix

Outdoor temperatures during the trial period:

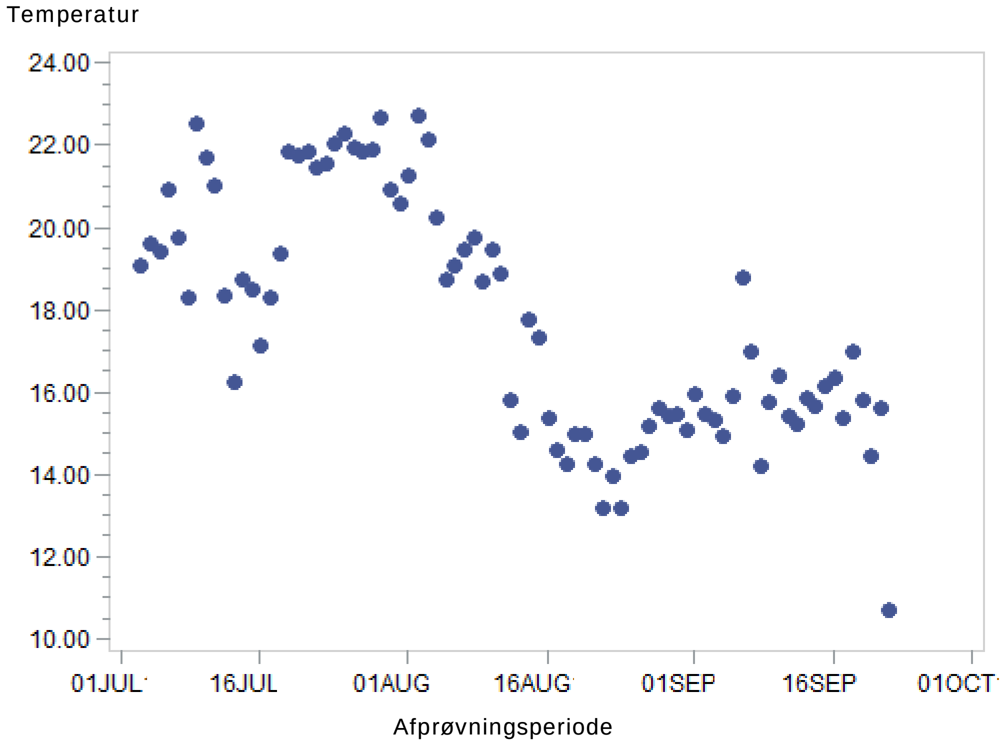

Figure A1. Outdoor temperature during the trial period. Each dot represents a calculated 24 hour mean of the outdoor temperature.

Fouling and lying behaviour

Areas in the farrowing pen where fouling was recorded (S3 and S4):

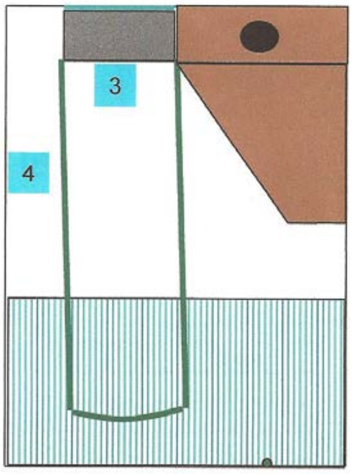

Figure A2. Areas S3 and S4 located in the farrowing pen where fouling was recorded.

Table A1. Fouling and lying behaviour in % when outdoor temperatures reached more than 19 °C.

	Control	Trough valve	One ceiling inlet	Transverse ceiling inlets in the section	P value
Lying behaviour:					
% sows in lateral position	53.1	51.6	55.7	58.7	0.51
% sows in prone position	28.1	34.1	37.1	29.8	0.087
% sows standing	18.4[a]	14.7[a]	7.46[b]	11.4[b]	0.036
Pen hygiene:					
% Solid floor dry (S3 – see figure A2)	81.3	86.0	83.0	79.8	0.47
% Solid floor dry (S4 -see figure A2)	58.5	57.5	61.4	53.6	0.79

Fouling and lying behaviour (outdoor temperatures below 19 °C):

Table A2. Fouling and lying behaviour in % when outdoor temperatures were below 19 °C.

	Control	Trough valve	One ceiling inlet	Transverse ceiling inlets in the section	P value
Lying behaviour:					
% sows in lateral position	44.3	44.5	48.8	49.9	0.57
% sows in prone position	43.1	46.9	42.3	40.6	0.75
% sows standing	12.5	8.5	8.9	9.50	0.12
Pen hygiene:					
% solid floor dry (S3 – see figure A2)	97.3	95.0	94.8	93.1	0.38
% solid floor dry (S4 - see figure A2)	73.2	74.2	64.5	71.2	0.24

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