

Piglets crushing rate related to sow foot lesions in the farrowing room



VITTORIO SALA¹, CLAUDIA GUSMARA¹, CATERINA ZOLIN¹, ANNAMARIA COSTA²

¹ Department of Veterinary Medicine

² Department of Health, Animal Science and Food Safety

Faculty of Veterinary Medicine, University of Milan, via Celoria 10, 20133 Milan, Italy

SUMMARY

The aim of this paper was to identify front and rear feet diseases of sows and its relation with the piglets crushing rate, in the farrowing crate.

The trial was performed in two piggeries, with 200 sows examined per farm A and farm B. The ratio primiparous (P) / multiparous (M) sows was respected for both farms (65%). Visual feet disease assessment was performed on the day the sows were moved from the gestation unit to the farrowing room. The protocol was based on the Welfare Quality Protocol, where a feet lesion is defined as a sow unable to use one or more limbs in a normal manner, varying in severity from reduced ability to bear weight, to total recumbency.

The lesion score was assessed by trained veterinarians on sows front and rear feet.

Five claw parameters were scored: heel overgrowth and erosion (HOE), toes overgrowth (length of toes, TO), overgrowth or length of dew claws (DC) mainly on the rear limbs, where the accessories hooves grow in a more consistent way, horizontal and vertical wall cracks (CWH, CWV) and white line cracks (WL).

Lesions scores were assessed according to a modified protocol by Deen et al. (2008), the Feet First method, stopping the maximum front score to 5, and for rear to 10. Each of the four feet was scored from one to 5, with score 1 meaning no lesion and score 5 (10 for rear feet) meaning a severe lesion. The sum of the score of the four claws was called the 'total score' (up to 20). At the end of the trial, since feet disease with score higher than 6 were rarely detected, the statistical analysis was performed on front/rear score up to 5.

The predominant type of wound, either on hind legs or on rear legs was, in both farms, heel overgrowth and erosion (HOE) followed by toes overgrowth (TO).

The number of born alive, mummified and stillborn, crushed, alive after 3 days, dead before weaning and number of weaned piglets were recorded.

Results highlighted that front lesions values were higher in the Farm A (0.73 vs 0.47 for M sows and 0.55 vs 0.26 for P sows, $P < 0.05$).

Score on rear limbs was affected by parity ($P < 0.001$), higher values were detected in multiparous sows, as it was expected.

Sows in Farm A, where gestation room had a concrete partly slatted floor, crushed more piglets per litter than sows of Farm B, with gestation rooms equipped with a concrete slatted floor, in the considered 3 d period (+ 0.3 for M sows and + 0.23 for P sows, $P < 0.001$) and showed higher values for front feet disease ($P < 0.05$).

The higher crushing rate determined by front lesions could be explained by the difficulty of the sow in lifting and turning to the rest position, this assumption needs further investigations, in larger scale, on the mechanics of movements exhibited by sows in farrowing crates equipped with different floors.

KEY WORDS

Sow; feet disease; piglet; crushing rate; slatted/full floor.

INTRODUCTION

In pig farming, the productive and economic losses are linked essentially to mortality rate, especially before weaning, and to growth delay in piglets. The first few days of life for the piglets are a critical phase and perinatal mortality represents an important cause of economic loss in pig production¹. Pre-weaning mortality is highest during farrowing and in the first days of the piglet's life² and it is directly relat-

ed to the environment and the management, as the litter size increases from 6-8 to 16-19 piglets, neonatal mortality increases from 10-15% to about 45%³.

Pre-weaning mortality rate is strictly connected to the management level of the farm, it ranges between 11% and 13%, when including a previous 7-8% of losses due to stillbirths⁴. As reported by previous studies, piglet crushing and starvation caused 50-80% of total piglet mortality in the farrowing room⁵. A higher percentage of crushed piglets, are predisposed to crushing for starvation (up to 43%), since a piglet that cannot have an adequate amount of food stays more time in proximity of the sow and is hence more at risk⁶. Healthy pigs crushed by their mother were estimated 18%⁷.

Corresponding Author:

Annamaria Costa (annamaria.costa@unimi.it).

Stillbirths generally account for 4-8% of all pigs born⁸, or 30-40% of the total mortality.

Crushing by the sow is a predominant cause of death in crates and pens⁹. Among the crushed piglets, some movements of the sow in the crate are riskful for the piglets, rolling behaviour can contribute up to 18-36% to crushing rate¹⁰ whereas in other studies it accounted for as many as 65-75%^{6,11}. However, discrepancies regarding piglets crushed by rolling behaviour seem large enough to suggest that environmental aspects may be involved⁹, and they mention particularly floor type as one such environmental factor¹¹.

Amongst deaths of liveborn piglets, crushing is by far the major cause¹². The term 'crushing' implies that deaths are due to trauma to the piglet's body by the sow. However, many piglets are killed by suffocation when trapped under the body of the sow for a prolonged time, and not as a direct result of traumatic injury. Some piglets die after very short time in contact with the sow, but these cases seemed to result from movements likely to cause extensive injuries, or the trapping of newborn pigs⁶.

Therefore, the organization and the design of the farrowing unit is important to limit the economic damage and to increase the productive efficiency of the animals¹³.

Another risk factor in crushing is feet disease in sow, a complex of wounds and lesions that lead to replacement and early culling of sows¹⁴, increasing the economic losses of a pig farm. Feet disease may affect reproduction of sows by influencing sows' longevity, behaviour and feed intake, leading to early culling¹⁵. Therefore, treatment and prevention of hoof diseases constitute an essential intervention for the maintenance of a high production standard in the farm, containing at the same time, the economic losses. Feet disease is the first cause of impaired animal welfare and it is allied to financial loss estimated at € 37 per sow feet in Germany¹⁶, and in a Dutch study, up to € 20 to € 30 per sow¹⁷. All these additional costs increased workload and veterinary costs¹⁸.

Among feet diseases, the most common injury is hyperkeratosis of the footpad, often related to trauma paving; fractures of the sole and / or heel are instead due to size incorrect slots of the grid, in which the hooves can get trapped. The separations along the white line can also be referred to the excessive pressure due to sow's weight on traumatizing floor types, while the nail wall fractures (horizontal or vertical) often happen in rapid growing animals not properly fed, with low addition of vitamins and microelements as zinc for example¹¹.

At last, the digital overgrowth or the excessive length of the hoofs (Spurs) is imputable to prolonged immobility periods of the sow. In all lesions, also secondary infections have to be taken into account, especially if they involve sow's articular bone structures¹⁸.

Also other conditioning factors are environment, management and genetics, which has an important role in osteochondrosis: the sow permanence on wet and fouled surfaces with urines and manure may reduce the consistency of feet structures, resulting in the softening of the horny layer, which can become more vulnerable¹¹.

The aim of this paper was to evaluate the effect of the severity level, expressed as a modified score of *Deen et al. with Zinpro, Feet First* 2008¹⁹, of front and rear feet disease in sows on piglets crushing rate, in two farms with different floor of farrowing crates and in gestation unit.

MATERIALS AND METHODS

Location and animals

Two farrow to finish farms (A and B), housing respectively 600 and 450 Italian large White sows, were involved in the trial. The first 30 days pregnancy was managed in a conventional stall, then, for the lasting days, sows were group housed in pens with 5-6 animals on partly slatted floor. In farm A the gestation room had a concrete partly slatted floor, gestation rooms in farm B had a totally slatted floor in concrete. One week before parturition, sows were moved to the farrowing unit.

In both farms, the floor of the farrowing crate was slatted. In farm A, a rubber mat was placed under the sow up to the 7th day post-partum, while in farm B the sow was lodged in the farrowing crate with slatted floor. Sows were fed twice daily by the automated liquid feeding plant. In both farms, piglets were weaned at 28 d of age.

Lesions scores assessment in sows

In both farms, the trial was replicated three times, a total of 200 sows was examined per farm A and farm B. The ratio primiparous (P) / multiparous (M) sows was respected for both farms (65%). Visual feet disease assessment was performed on the day the sows were moved from the gestation unit to the farrowing room. The protocol was based on the Welfare Quality Protocol²⁰, where a sow with feet lesion is defined as a sow unable to use one or more limbs in a normal manner, varying in severity from reduced ability to bear weight, to total recumbancy.

The foot lesions score was assessed by trained veterinarians on sows front and rear feet.

Five claw parameters were scored: heel overgrowth and erosion (HOE), toes overgrowth (length of toes, TO), overgrowth or length of dew claws (DC) mainly on the rear limbs, where the accessories hooves grow in a more consistent way, horizontal and vertical wall cracks (CWH, CWV) and white line cracks (WL).

Scores were given according to a modified protocol by Deen et al. (2008), the Feet First method¹⁹, stopping the maximum front score to 5, and for rear to 10. Each of the four feet was scored from one to 5, with score 1 meaning no lesion and score 5 (10 for rear feet) meaning a severe lesion. The sum of the score of the four claws was called the 'total score' (up to 20).

Piglets performance

Number of piglets born alive, mummified and stillborn piglets, crushed piglets, alive piglets after 3 days, dead piglets before weaning, number of weaned piglets were recorded for each litter.

Trained veterinarians performed the post-mortem examination of each dead piglet to confirm the cause of death. Crushed piglets, stillbirths and mummified were identified as reported¹¹.

During the three days after farrowing, the number and the causes of piglet mortality, i.e. crushing vs non-crushing (including starvation, diarrhoea, cannibalism or malformations) were recorded. The first three days of observation were considered in accordance with international references, because approximately 50% of these pre-weaning death losses occur in this time²¹.

Statistical analysis

A variance analysis was used to process data (Proc GLM of the SAS statistical package 9.3, 2016²²). The effects of sows parity, farm (different type of floor of the farrowing crate) and their interaction (parity x farm) was tested on severity of feet disease (front/rear/total), piglets crushing rate, number of piglets born alive, mummified and stillbirth piglets, alive after three days, total dead before weaning and weaned.

Then, a variance analysis (Proc GLM of the SAS statistical package 9.3, 2016) was run to evaluate feet disease effect (front vs rear vs total) on piglets crushed number.

RESULTS

The results obtained in the two farms are shown in Table 1 and Table 2. Front lesions values were higher in the Farm A (0.73 vs 0.47 for M sows and 0.55 vs 0.26 for P sows, $P < 0.05$). Since feet disease with score higher than 6 were rarely detected, the statistical analysis was performed on front/rear score up to 5.

Feet disease score on rear limbs was affected by parity ($P < 0.001$), higher values were detected in multiparous sows, as it was expected.

In farm A, the percentage of sows with podal lesions was higher in comparison with farm B, either for P ($P < 0.001$) and M sows ($P < 0.01$).

In none of the two farms were detected phlegmons of the coronary band. Some types of wounds or feet disease detect-

ed in the two farms, with the assessed score, are shown in Figures 2 to 6.

The predominant type of wound, either on hind legs or on rear legs was, in both farms, heel overgrowth and erosion (HOE) followed by toes overgrowth (TO), as reported in Table 2, feet disease of sows were around 72%. The feet disease score with highest incidence was detected to be R2 and R4.

Another frequently detected lesion was overgrowth of dew claws (DC) mainly on the rear limbs, where the accessories hooves grow in a more consistent way. The horizontal and vertical wall cracks (CWH, CWV) and white line (WL) cracks were prevalent on the rear limbs and in multiparous sows.

Crushed piglets number per litter was depending on farm ($P < 0.001$), with 0.73 for M sows and 0.71 for P sows in farm A; 0.39 for P sows and 0.20 for P sows in farm B.

The number of born alive piglets was higher in farm A ($P < 0.05$) and in M sows ($P < 0.001$).

Mummified and stillbirth piglets were more in M sows ($P < 0.001$) in both farms. Parity affected the number of piglets live at the 3rd day (0.001), the number of piglets dead before weaning ($P < 0.01$), the number of total dead piglets ($P < 0.001$).

The number of weaned piglets resulted affected by parity ($P < 0.01$) and by the interaction farm x parity ($P < 0.05$).

Sows in farm A produced more born alive piglets in comparison with farm B ($P < 0.05$).

Farm A sows crushed more piglets per litter in the considered 3 d period (+ 0.3 for M sows and + 0.23 for P sows, $P < 0.001$) and showed higher values for front feet disease ($P < 0.05$).

Table 1 - Mean values of feet disease of the sows according to parity and farm, sows and piglets productive performance.

Item	Farrow	FARM A	SEM	FARM B	SEM	Farrow	FARM A	SEM	FARM B	SEM
Lameness mean score (front)		0.73	0.11	0.47	0.10		0.55	0.12	0.27	0.12
Lameness mean score (rear)		2.57	0.17	2.40	0.15		1.76	0.18	1.39	0.19
Lameness mean score (total)		3.30	0.24	2.87	0.21		2.31	0.25	1.66	0.27
% of sows with podal lesion		53	0.86	51.5	0.95		27	0.45	21	0.64
Number of piglets born alive		12.53	0.26	12.21	0.23		10.57	0.28	11.39	0.29
Number of mummified and stillbirth piglets	M	0.44	0.06	0.39	0.06	P	0.15	0.07	0.13	0.07
Number of crushed piglets		0.73 (6%)	0.07	0.34 (3%)	0.07		0.72 (6%)	0.08	0.21 (2.7%)	0.08
Number of alive piglets after 3 days		11.36	0.33	11.11	0.29		9.70	0.35	10.06	0.37
Number of piglets dead before weaning		0.30	0.06	0.33	0.05		0.11	0.06	0.12	0.07
Number of dead piglets (total)		1.48	0.16	1.35	0.14		0.97	0.18	0.67	0.19
Number of weaned piglets		11.06	0.29	10.85	0.26		9.59	0.32	10.72	0.33

Table 2 - Percentages of the combinations front x rear feet disease in the trial.

Front lameness %	Rear lameness %						Total
	0	1	2	3	4	5	
0	28.19	1.78	26.41	0.89	14.24	2.97	74.48
1	0.00	2.67	1.48	0.89	2.08	0.00	7.12
2	0.00	0.00	2.08	3.56	7.12	0.89	13.65
3	0.00	0.00	2.08	0.00	0.59	0.30	2.97
4	0.00	0.00	0.00	0.00	0.30	0.29	0.59
5	0.00	0.00	0.00	0.00	0.00	1.19	1.19
Total %	28.19	4.45	32.05	5.34	24.33	5.64	100.00

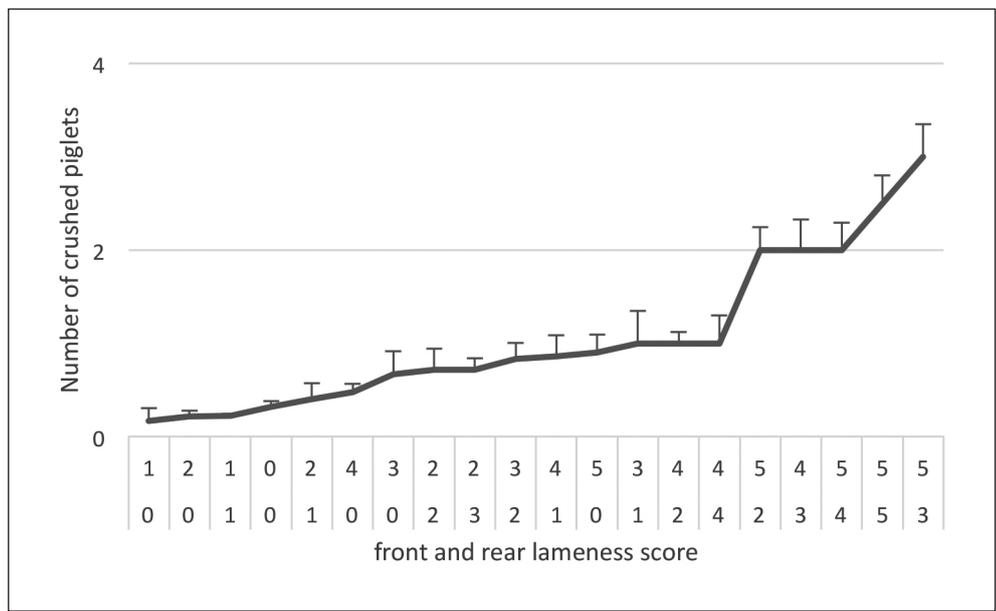


Figure 1
Number of crushed piglets according to front and rear foot lesion in sows.

Crushed piglets in relation to front and rear lesion score

The analysis limited to score 1-5 for front and rear feet, showed a significant effect ($P < 0.001$, Figure 1) of the podal score severity on the increase of crushed piglets. In the analysis performed on the different combinations of front/rear legs lesions score piglets crushing incidence resulted affected by, as shown in Figure 1, where the highest number of crushed piglets occurred with front score higher than 4. More specifically, considering the combination of lesions observed in front and rear legs on sows, Table 3 shows that the number of crushed piglets per litter is higher for rear score 5 and that this number increases with the front score. Crushed piglets/litter increased from 0.90 with rear score 5 and front score 0, up to 3 crushed piglets/litter with rear score 5 and front score 3 ($P < 0.001$). Since two or more piglets crushed are considered as a limit to distinguish crushers from non-crushers sows²³, it follows that the score combination F3 x R4 represented a threshold value for crushing in the present study.

DISCUSSION

The predominant type of wound, either on hind legs or on rear legs was, in both farms, heel overgrowth and erosion

Table 3 - Combination of front and rear podal scores and level of significance on number of crushed piglets for litter.

Score	R0	R1	R2	R3	R4	R5
F0	0.31	0.17	0.21a	0.6	0.48A	0.90A
F1		0.22	0.40	1	0.86a	
F2			0.71b	0.8	1Bb	2
F3			0.71b		2Bb	3B
F4					1	2
F5						2.5B

A, B: values on the same column with these superscript differ for $P < 0.001$; a, b: values on the same column with these superscript differ for $P < 0.01$.

(HOE) followed by toes overgrowth (TO), in agreement with¹⁸. Heel lesions are very common among sows²⁴. The high percentage of sows with heel lesions (72%) in this study is in agreement with the results of previous studies¹⁸. A high difference for detected lesions between the two farms was noticed in this trial, in agreement with previous studies²⁵. Values detected for lesions in Farm A were 7%, similarly to those found by²⁶. The significantly higher incidence of crushed piglets in Farm A in comparison with Farm B seems related to the higher incidence of front feet disease detected in sows of farm A ($P < 0.001$), where a rubber mat was placed on the floor, beneath the body of the animal and, sows were lodged on different types of floor. The crushing usually occurs when the sow changes its position from up standing to the lying position, from a sternal decubitus to a lateral one and during rolling movements²¹. Confinement for the first 4 d of lactation did reduce piglet mortality in that period, and that the lowest piglet mortality was achieved when sows were confined before farrowing and for 4 d after farrowing¹³. At the visual observation, the sows with front lesions, when trying to get up in the farrowing crate, tended to slip on the mat. Also when sitting, the sows affected by front feet disease tends to lay down steeply on the floor, increasing the crushing risk²⁷, feet disease leads to uncontrolled lying-down behaviour and, as a consequence, it may augment the risk of crushing piglets. The farrowing crate, which is widely use in modern pig husbandry, represents a tool to reduce the piglet crushing by limiting the sow's postural movement since 1960s, by the conversion from free-range pens to conventional crates. Our study seems to confirm that loose housing of dry sows in pens with partly slatted concrete floors is associated with severe claw problems, and that a continually wet floor may cause softening of the hoof and predisposes to hoof and sole trauma²⁸. These results seem to highlight a direct relationship between crushing ad feet disease. However, the direct effect of feet disease on reproduction (i.e. direct improvement or deterioration of the breeding or farrowing performance of a sow), is



Figure 2 - Dew claws overgrowth - Score 2.



Figure 5 - Mono-digital heel overgrowth and erosion - Score 3.



Figure 3 - Cracked wall (vertical) - Score 1.



Figure 6 - Unilateral dew claw fracture - Score 3.



Figure 4 - Heel overgrowth and erosion - Score 1.

less clear. Studies did not find any effect²⁹, whereas other studies described a negative relationship between feet disease and farrowing performance¹⁶.

Front injuries resulted more important if compared to those detected on rear legs; this could motivate further studies to investigate the interaction of risk factors in crushing²⁷. In any case, the foot lesions had a noticeable impact either on losses in the delivery room (especially in the first 3 days of life but also in the following period).

CONCLUSIONS

In pig farming, foot lesions are an important factor for increased piglets' losses in the farrowing room, mainly in the first three days of life but also in the following period, affecting the number of weaned piglets. Further investigations on risk factors leading to feet disease, front vs rear feet, and crushing rate in relation to farrowing crate design are needed. The scoring system applied to our experimental program on foot lesions of sows, not only to rear but also to front legs, gave new information. This assumption needs further investigations on the mechanics of movements exhibited by sows in the farrowing crates especially when affected by feet disease on front feet, as an important cause in crushing rate.

References

1. Marchant J.N., Rudd A.R., Mendl M.T., Broom D.M., Meredith M.J., Corning S., Simmins P.H. (2000) Timing and causes of piglet mortality in alternative and conventional farrowing systems. *Vet Rec.* 147:209-214.
2. Andersen I.L., Haukvik I.A., Bøe K. (2009) Drying and warming immediately after birth may reduce piglet mortality in loose-housed sows. *Animal.* 3:592-597.
3. Blasco A., Bidanel J. P., and Haley C. S. (1995) Genetics and Neonatal Survival. In: M.A. Varley (ed.) *The Neonatal Pig. Development and Survival*, pp 17-38. CAB International, Wallington, Oxon, UK.

4. Kirkden R.D., Broom D.M., Andersen I.L. (2013) Invited review: piglet mortality: management solutions. *J Anim Sci.* 91:3361-3389.
5. Jarvis S., D'Eath R.B., Fujita K. (2005) Consistency of piglet crushing by sows. *Anim Welfare.* 14:43-51.
6. Weary D.M., Pajor E.A., Fraser D., Honkanen A. (1996). Sow body movements that crush piglets: a comparison between two types of farrowing accommodation. *Applied Animal Behaviour Science* 49, 149-158.
7. English P.R., Smith W.J. (1975) Some causes of death in neonatal piglets. *Veterinary Annual* 15, 95-104.
8. English P.R., Edwards S.A. (1996) Management of the nursing sow and her litter. In: Dunkin A.C., Taverner M. (Eds.), *Pig Production*. World Animal Science, Vol. C10. Elsevier, Amsterdam, pp. 113-140.
9. Damm B. I., B. Forkman and Pedersen L. J. (2005) Lying down and rolling behaviour in sows in relation to piglet crushing. *Appl. Anim. Behav. Sci.* 90:3-20.
10. Vieuille C., Berger F., Le Pape G., Bellanger D. (2003) Sow behaviour involved in the crushing of piglets in outdoor farrowing huts - a brief report. *Applied Animal Behaviour Science* 80, 109-115.
11. Weary D.M., Phillips P.A., Pajor E.A., Fraser D., Thompson B.K. (1998) Crushing of piglets by sows: effects of litter features, pen features and sow behaviour. *Appl Anim Behav Sci.* 61:103-111.
12. Sala V., Fantinati P., 2012. Implicazioni manageriali e strutturali nello schiacciamento dei suinetti. *Summa Animali da reddito*, 29 (6): 30-34.
13. Hales J., Moustsen V.A., Devreese A.M., Nielsen M.B.F. and Hansen C.F. (2015) Comparable farrowing progress in confined and loose housed hyper-prolific sows. *Livest. Sci.* 171:64-72.
14. Anil S.S., Anil L. & Deen J. (2007) Factors associated with claw lesions in gestating sows. *Swine health and Production*, 15:78-83.
15. Jensen T.B., Bonde M.K., Kongsted A.G., Toft N. and Sørensen J.T. (2010) The interrelationships between clinical signs and their effect on involuntary culling among pregnant sows in group-housing systems. *Animal* 4, 1922-1928. Johnson RW 1997. Inhibition of growth by pro-inflammatory cytokines: an integrated view. *Journal of Animal Science* 75, 1244-1255.
16. Grandjot G. (2007) Claw problems cost money SUS-Schweinezucht und Schweinemast Landwirtschaftsverlag GmbH. Munster-Hiltrup, Germany 5, 28-31.
17. Schuttert M. (2008) The economical impact of lameness in sows. Feet-First™ Symposium on Sow Lameness, Asten/Sterksel, The Netherlands, 4 pp.
18. Pluym L., Van Nuffel A., Van Weyenberg S. and Maes D. (2013) Prevalence of lameness and claw lesions during different stages in the reproductive cycle of sows and the impact on reproduction results. *Animal.* 7(7):1174-1181.
19. Deen J., Schuttert M., van Amstel S., Ossent P., van Barneveld R. and Zinpro Corporation. (2008) Feet first lesion scoring guide, produced by the Feet First Project.
20. Welfare Quality (2009) Welfare Quality assessment protocol for pigs (sows and piglets, growing and finishing pigs). Welfare Quality Consortium, Lelystad, The Netherlands.
21. Danholt L., Moustsen V.A., Nielsen M.B.F., Kristensen A.R. (2011) Rolling behaviour of sows in relation to piglet crushing on sloped versus level floor pens. *Livest Sci.* 141:59-68.
22. SAS statistical package 9.3, 2016.
23. Wechsler B., Heggin D. (1997) Individual differences in the behaviour of sows at the nest-site and the crushing of piglets. *Appl. Anim. Behav. Sci.* 51, 39-49.
24. Anil S.S. (2011) Epidemiology of lameness in breeding female pigs. PhD University of Minnesota.
25. Heinonen M., Oravainen J., Orro T., Seppä-Lassila L., Ala-Kurikka E., Virolainen J., Tast A. and Peltoniemi O.A.T. (2006) Lameness and fertility of sows and gilts in randomly selected loose-housed farms in Finland. *The Veterinary Record* 159, 383-387.
26. Marchant J.N., Broom D.M., Corning S. (2001) The influence of sow behavior on piglet mortality due to crushing in an open farrowing system. *Animal Science*, 72:19-28.
27. Bonde M., Rousing, T., Badsberg H., Sørensen J. (2004) Associations between lying-down behaviour problems and body condition, limb disorders and skin lesions of lactating sows housed in farrowing crates in commercial sow herds. *Livestock Production Science.* 87, 179-187.
28. Rowles C. (2001) Sow lameness. *Journal of Swine Health and Production* - May and June. 130-131.
29. Willgert K. (2011) The economic and welfare impact of lameness in sows in England. Retrieved January 10, 2012, from http://www.fao.org/fileadmin/user_upload/animalwelfare/TheeconomicandwelfareimpactoflamenessinsowsinEngland.pdf.