Behaviour of sows and their piglets in different crated and free farrowing systems: biology needs to come before technology



- Inger Lise Andersen, Professor of Ethology and Animal Welfare, Dep. of Animal and Aquacultural Sciences, Faculty of Bioscience, Norwegian University of Life Sciences

4 initial questions and Design Criterias based on the biology of the sow

What kind of animal or biological system are we designing an environment for?

What are the basic behavioural needs of the sow at farrowing and lactation, and how can we stimulate her to become a good mother?

How can we create an environment where the sow is confident, relaxed and attentive towards her young?

What factors are important for the farmer to have good working conditions and a good relationship to his/her pigs?







Fundamental decisions about reproduction – evolution of life histories

- Two fundamental decisions about reproduction (e.g. Clutton-Brock and Godfray, 1992):
  - How much of the resources available to them should be spent on reproduction instead of their own continued growth and survival
  - How to devide the resources that they allocate to reproduction among their offspring







Trade-offs and maternal investment

- Each reproductive effort is associated with a cost in terms of reduced future survival rate and fecundity (e.g. Williams, 1966; Gustafsson and Sutherland, 1988)

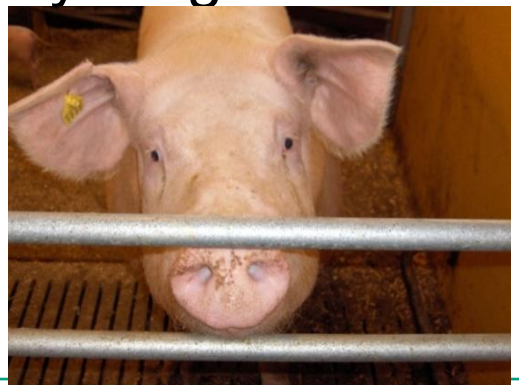




Andersen, I. L., Nævdal, E. and Bøe, K. E., 2011. Maternal investment, sibling competition, and offspring survival with increasing litter size and parity in pigs (*Sus scrofa*). Behav. Ecol. Sociobiol., 65: 1159-1167.

Trade -off between number and fitness of offspring

- Sows produce more offspring than normally raised, and pigs fit the pattern of ‘facultative siblicide’ to a large extent in that (e.g. Fraser et al., 1995):
  - producing an extra young only imply a small extra investment for the mother
  - intense sibling competition determines the number of offspring raised
  - size asymmetry ensures that the most vital young survive







Norsvin Landrace (NL)
n=12



Norsvin Duroc (ND)
n=12

Piglets (n=469)



Crossbreed
NL×Y
n=14

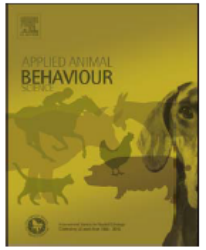
Consequences of increased litter size in three breeds

Applied Animal Behaviour Science 193 (2017) 7–14

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim



Trade-offs between litter size and offspring fitness in domestic pigs subjected to different genetic selection pressures

Marko Ocepek*, Ruth C. Newberry, Inger Lise Andersen

Norwegian University of Life Sciences, Department of Animal and Aquacultural Sciences, PO Box 5003, 1432 Ås, Norway

Litter size effects:

	Litter size
Nursing success (%)	*** ↓
Pre-massage duration (s)	* ↑
Post-massage duration (s)	*** ↑
Nursing interval duration (min)	*** ↑
Missed milk let-down (% of litter)	*** ↑
Monopolized two teats (% of litter)	*** ↑
Survived to weaning (n of piglets)	** ↓
Body weight at weaning (kg)	* ↓
Coefficient of variation in weight at weaning (%)	** ↑
Mortality (% of litter)	*** ↑
Maternal crushing (% of litter)	** ↑
Starved (% of litter)	*** ↑



Maternal investment

Consequences of litter investment on physical characteristics (BCL & SLD) in primiparous and multiparous sows

Can a super sow be a robust sow? Consequences of litter investment in purebred and crossbred sows of different parities[1]

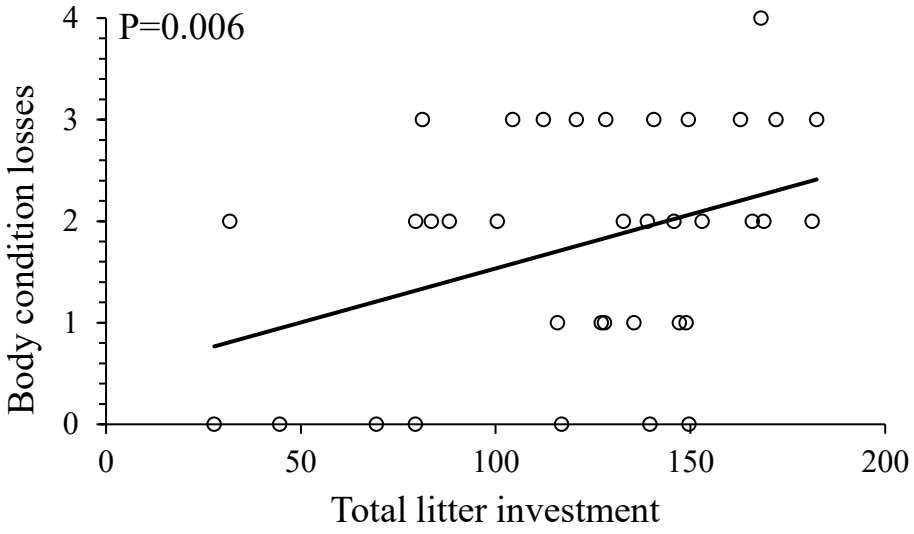
M. Ocepek,*[2] I. Andersen-Ranberg,† S. A. Edwards,‡ B. Fredriksen,§ T. Framstad,# and I. L. Andersen*

*Norwegian University of Life Sciences, Department of Animal and Aquacultural Sciences, PO Box 5003, 1432 Ås, Norway; †Topigs Norsvin, PO Box 504, 2304 Hamar, Norway; ‡Newcastle University, School of Agriculture, Food & Rural Development, Agriculture Building, Newcastle on Tyne NE1 7RU, UK; §Animalia, Meat and Poultry Research Centre, Pig health service, Lørenveien 38, 0513 Oslo, Norway; and #Norwegian University of Life Sciences. Department of Production Animal Clinical Sciences, PO Box 8146 Dep, 0033 Oslo, Norway

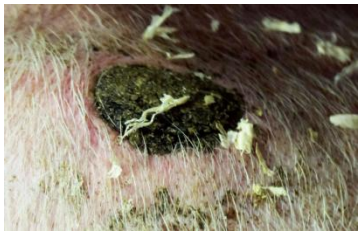
© 2016 American Society of Animal Science. All rights reserved.

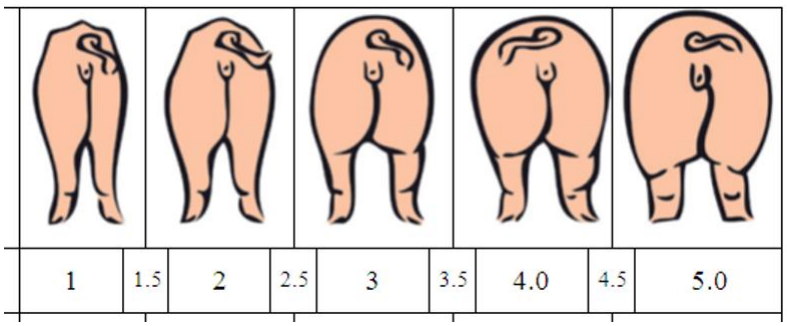
J. Anim. Sci. 2016.94
doi:10.2527/jas2016-0386

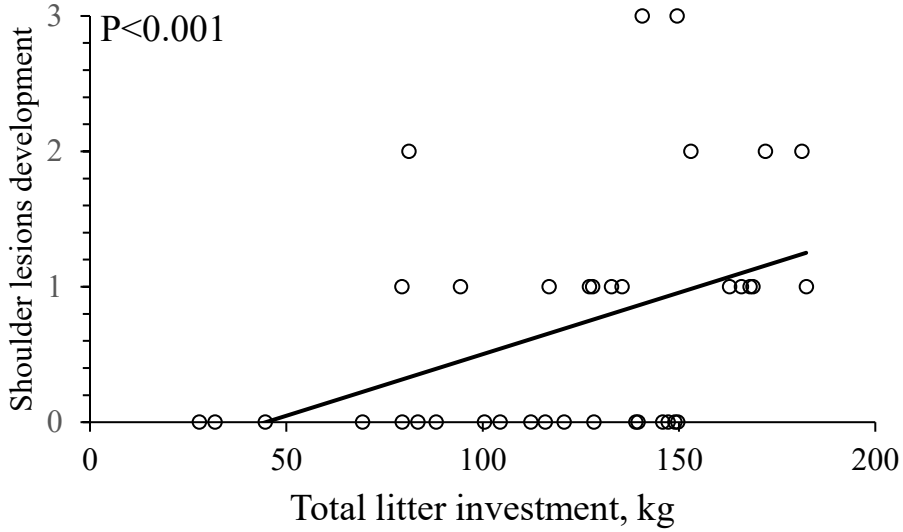
Litter investment related to BCS and SL







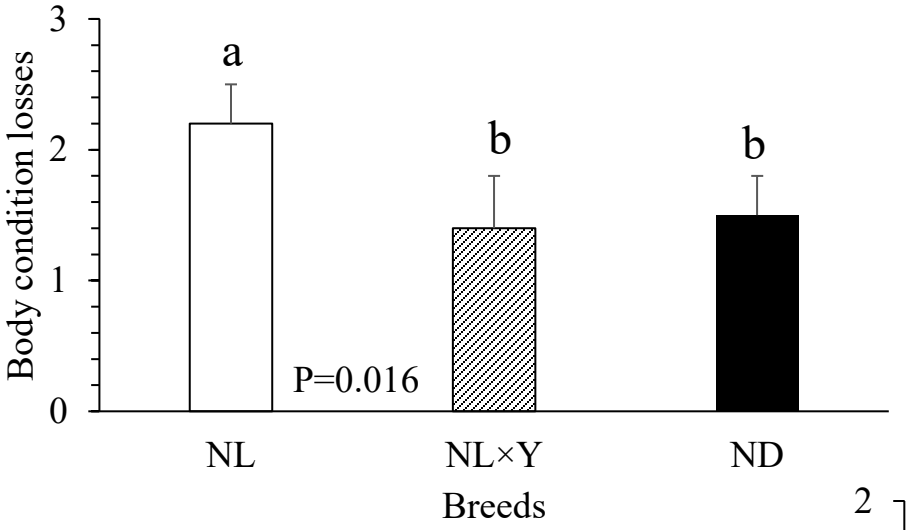




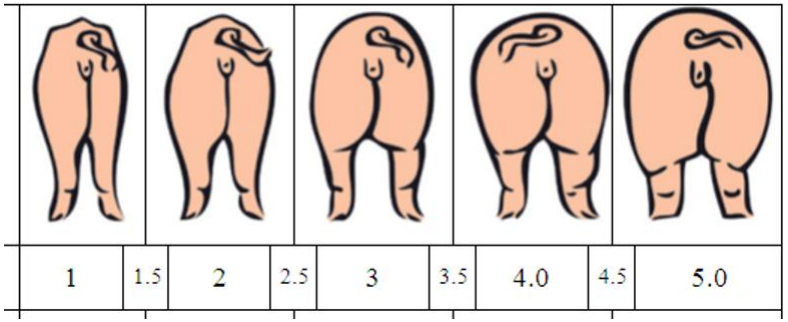
Ocepek et al., 2016

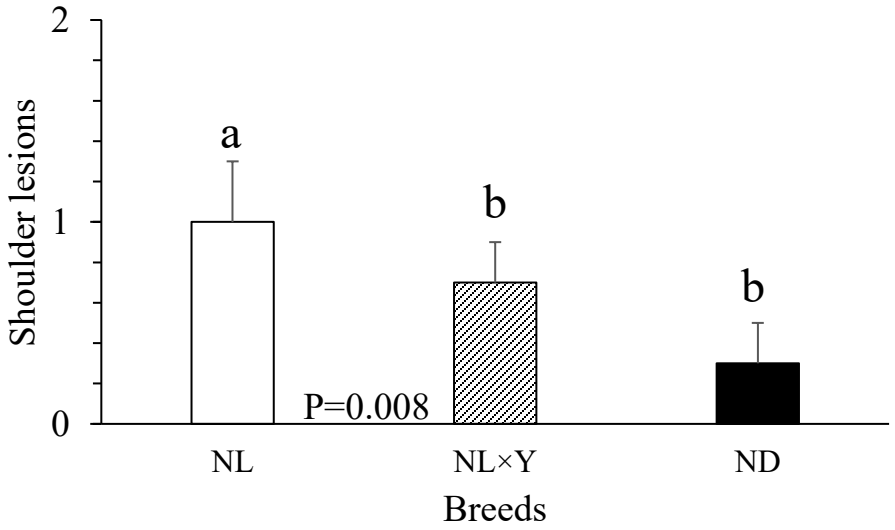
J. Anim. Sci. 2016.94
doi:10.2527/jas2016-0386

BCS and SL in three breeds





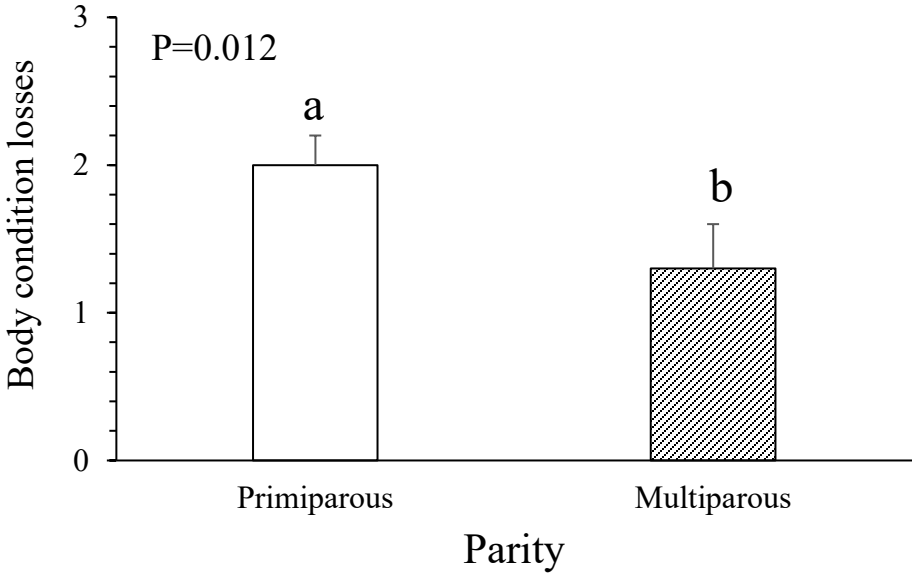




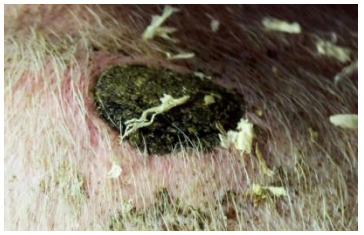
Ocepek et al., 2016b

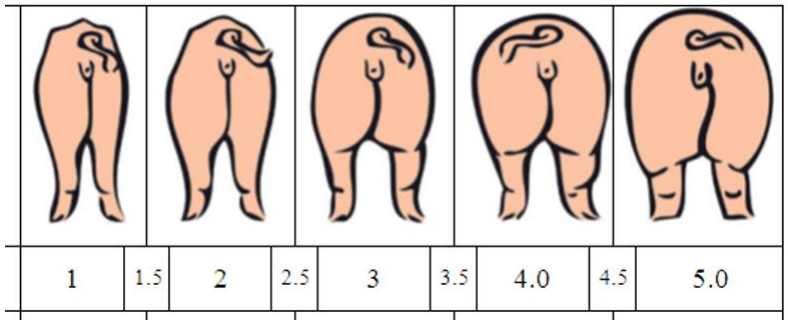
J. Anim. Sci. 2016.94
doi:10.2527/jas2016-0386

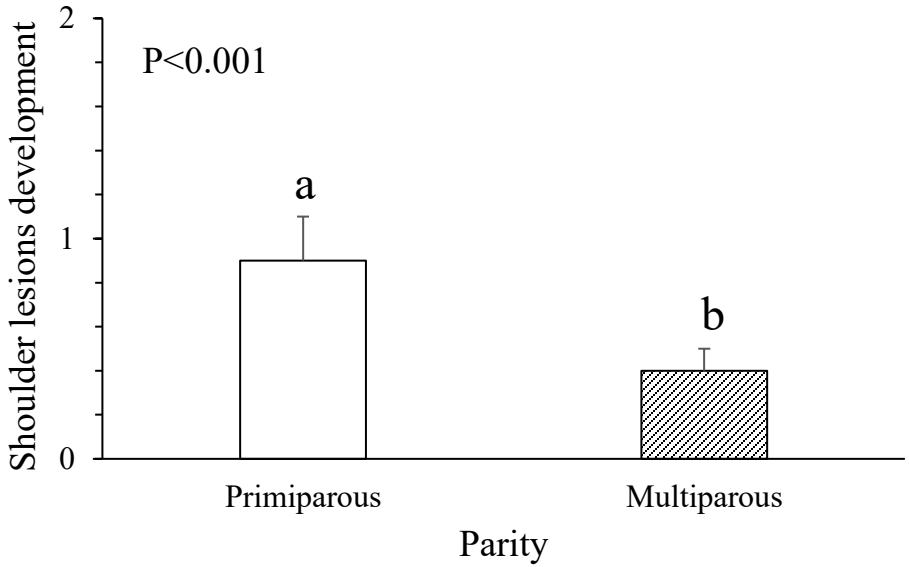
BCS and SL in relation to parity











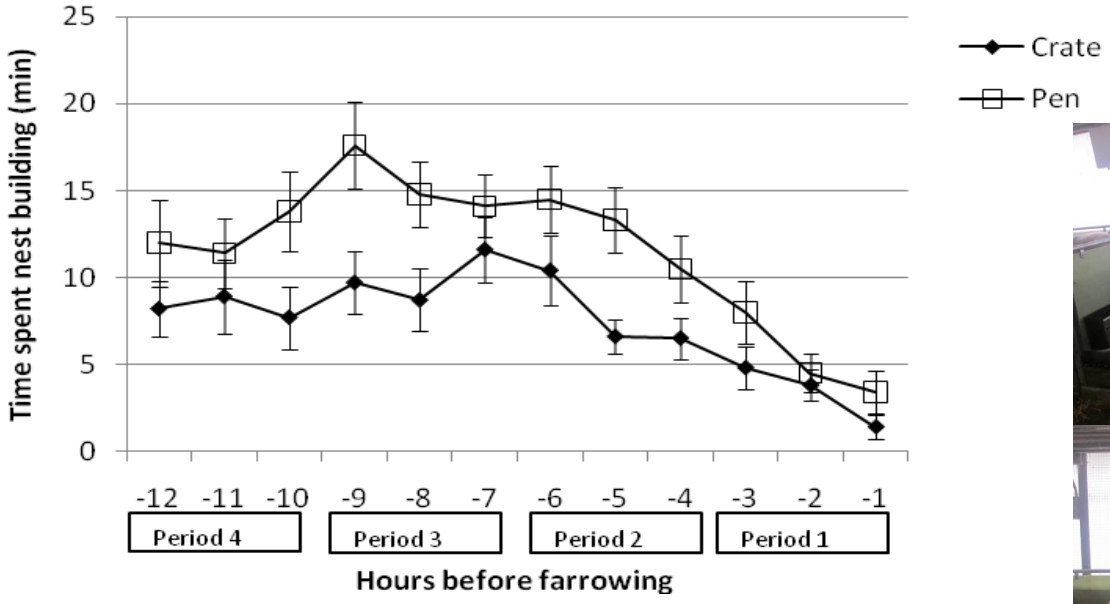
Increasing litter investment and/or sow longevity?

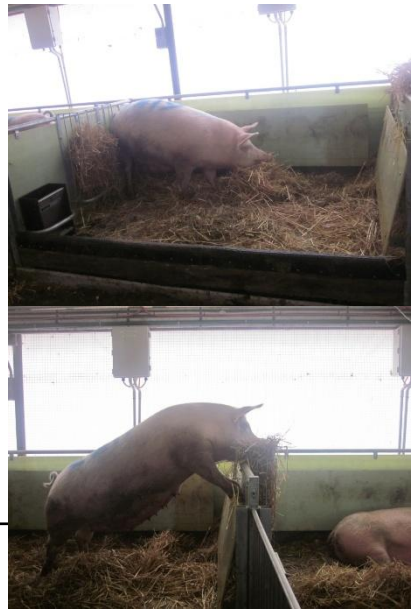
Ocepek et al., 2016b

J. Anim. Sci. 2016.94
doi:10.2527/jas2016-0386

Maternal behavioural traits important for loose-housed sows

Nest building behavior

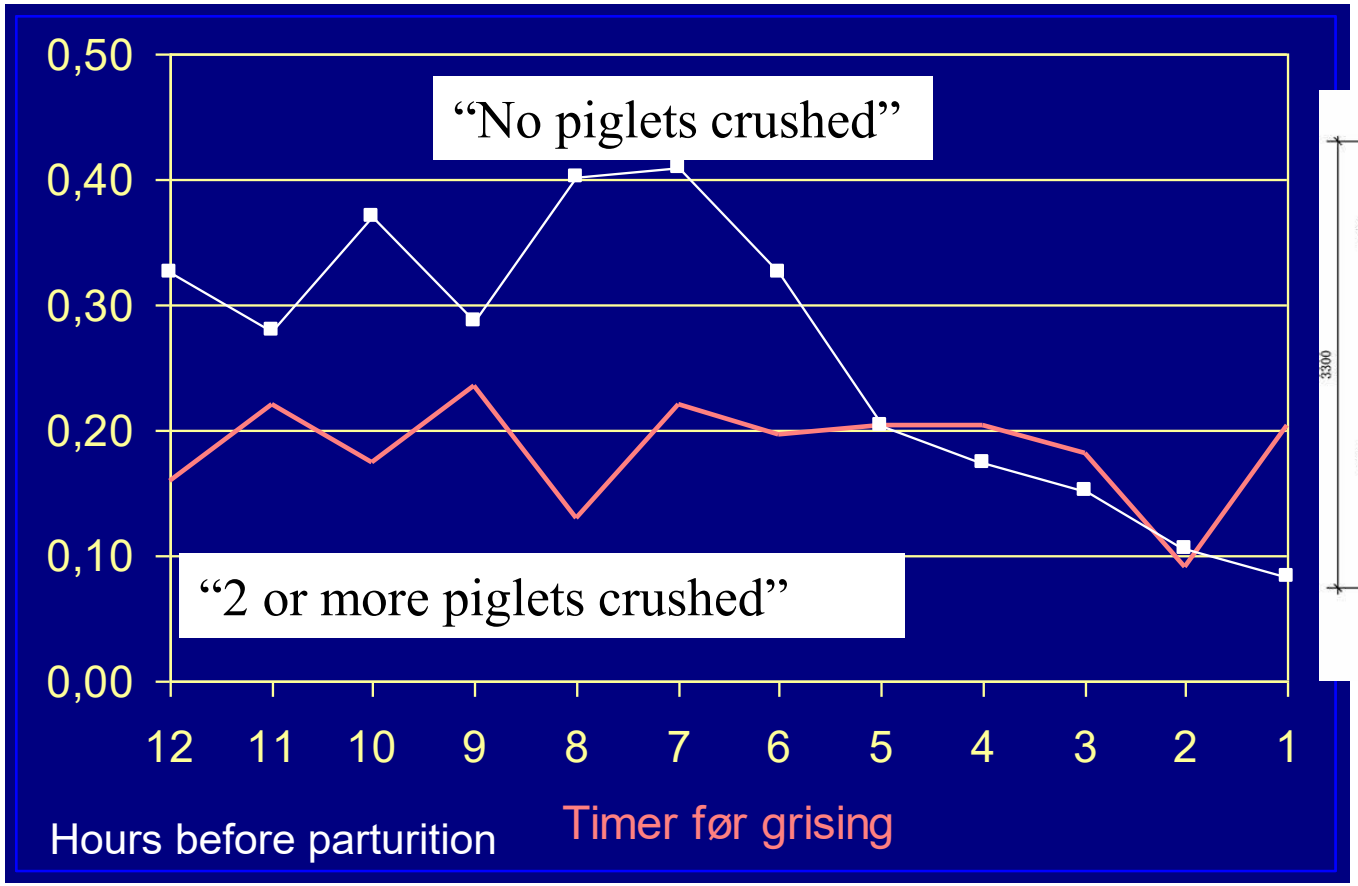


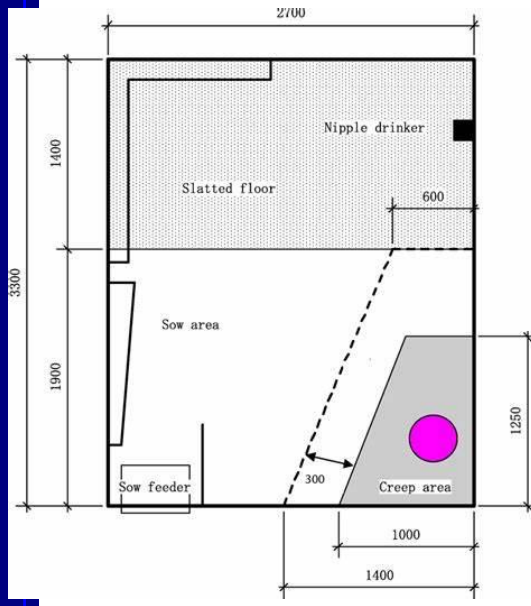


	CRATE (n=23)	PEN (n=21)	$\chi^2_{1,39}$	P-value
Nest building (min)	101.2±12.6	148.8±16.0	5.5	<0.05
Number barbiting	42.3±4.9	2.2±1.0	14.0	<0.001
Number quick flop	5.4±1.1	2.3±0.8	4.7	<0.05
Posture changes	22.0±3.8	32.8±5.3	5.7	<0.05

Inger Lise Andersen, Guro Vasdal, Lene Juul Pedersen, 2014. Nest building and posture changes and activity budget of gilts housed in pens and crates. Applied Animal Behaviour Science,159, 29-33, https://doi.org/10.1016/j.applanim.2014.07.002.

Proportion of time (% av obs) spent nest building the last 12 hours before parturition.





8.9 m ^{2}

Latency to respond to piglet distress calls were longer and latency to first nose contact with a piglet after presentation of distress calls were longer for the ones that crushed several piglets than sows that did not crush any.

Andersen, I. L., Berg, S and Bøe, K. E., 2005. Crushing of piglets by the mother sow (Sus scrofa) – purely accidental or a poor mother? Appl. Anim. Behav. Sci. 93: 229-243

Some findings regarding nest building material

Straw resulted in a greater variety of nest building behavioural elements, increased time spent resting and reduced the incidence of oral stereotypies compared to sows that had access to peat or only sawdust (Rosvold, E. M, Framstad, T., Newberry, R. C. & Andersen, I. L., 2018**.** Nest-building behaviour and activity budgets of sows provided with different materials. *Appl. Anim. Behav. Sci*., 200, 36-44. https://doi.org/10.1016/j.applanim.2017.12.003, 2018.)

Sows provided with straw or peat as nesting material show a lower frequency of negative communication towards piglets compared to controls (Rosvold, E. M., Newberry, R. & Andersen, I. L., 2019. Early mother-young interactions in domestic sows - nest-building material increases maternal investment. *Appl.* Anim. Behav. Sci., 104837.https://doi.org/10.1016/j.applanim.2019.104837, 2019).

Straw results in a higher proportion of sow-initiated nursing bouts and successful nursing bouts (i.e. with milk let-down) than sows in the peat and control groups (Rosvold et al., 2019).

Shorter farrowing duration when sows receives straw than when peat or no specific material is used, and percentage of stillborn was lowest in the straw group (Rosvold, E. M. & Andersen, I. L., 2019. Straw vs. peat as nest-building material – The impact on farrowing duration and piglet mortality in loose-housed sows. Livest. Sci., https://doi.org/10.1016/j.livsci.2019.05.014.)

Maternal behavioural traits

Developing a qualitative score

Nest building behavior

Sow communication

Sow carefulness

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim



Research paper

What makes a good mother? Maternal behavioural traits important for piglet survival

Marko Ocepek*, Inger Lise Andersen

Norwegian University of Life Sciences, Department of Animal and Aquacultural Sciences, P.O. Box 5003, 1432 Ås, Norway

Research design and the aim of the study

Maternal behavioural ⇔ Piglet survival

- Experimental setup



Norsvin Landrace (NL; n=12)



Norsvin Duroc (ND)
n=12



Crossbreed NL×Y
n=14

Piglets (n=469)

Ocepek and Andersen, Applied Animal Behaviour Science 193 (2017) 29–36

- Commercial herds (n=45; sows=895)

Ocepek et al., Journal of Animal Science 2017

Sow behavioural traits/scores and piglet survival

Sow communication | **Sow carefulness**

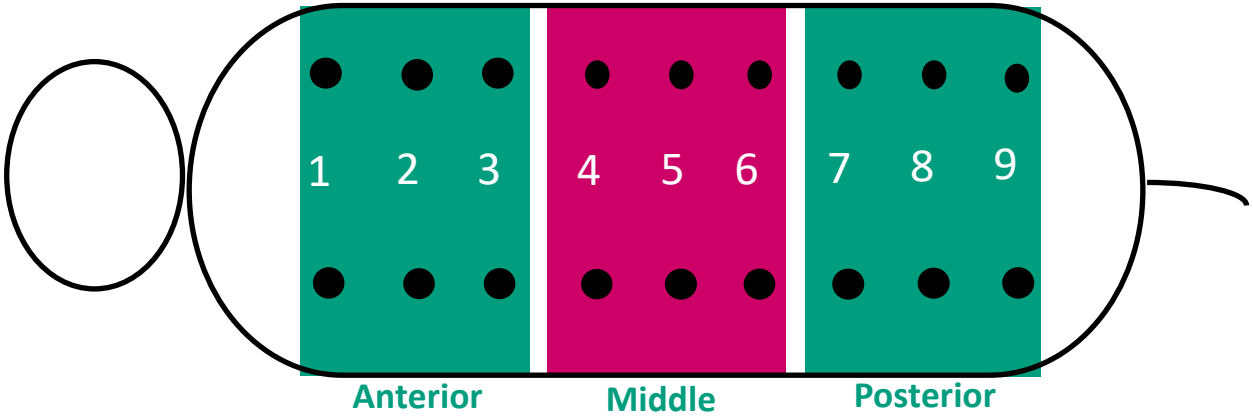
Traits	NBA		COM		CARE	
	χ^2	P	χ^2	P	χ^2	P
Postnatal mortality (% of litter)	8.4	0.004	103.7	<0.001	60.7	<0.001
Starvation (% of litter)	3.6	ns	6.9	0.009	0.2	ns
Maternal crushing (% of litter)	60.3	<0.001	42.0	<0.001	9.5	0.002
Weaned piglets (number)	2.1	0.043	3.1	0.004	2.3	0.003

Ocepek, M., Inger Lise Andersen, 2017. What makes a good mother? Maternal behavioural traits important for piglet survival, Applied Animal Behaviour Science, Volume 193, Pages 29-36, https://doi.org/10.1016/j.applanim.2017.03.010.

Ocepek M, Rosvold EM, Andersen-Ranberg I, Andersen IL., 2017. Can we improve maternal care in sows? Maternal behavioral traits important for piglet survival in loose-housed sow herds. J Anim Sci. Nov;95(11):4708-4717. doi: 10.2527/jas2017.1725. PMID: 29293724; PMCID: PMC6292299.

Ocepek M, Andersen IL, 2018. Sow communication with piglets while being active is a good predictor of maternal skills, piglet survival and litter quality in three different breeds of domestic pigs (Sus scrofa domesticus). PLoS ONE 13(11): e0206128. https://doi.org/10.1371/journal. pone.0206128

Side-effects of the breeding





1st day post partum: middle teats: 49% of the lower teats were not in use; posterior teats: 55% of the lower teats were not in use.

Ocepek M, Andersen-Ranberg I, Edwards SA, Andersen IL., 2016. Udder characteristics of importance for teat use in purebred and crossbred pigs. J. Anim Sci. 2016 Feb;94(2):780-8. doi: 10.2527/jas.2015-9420. PMID: 27065148.

Production results TN70 Norwegian hybrid sows

Kullresultater fordelt på kullnummer

År	2025				
Kullnummer ▲ Parity	Antall kull Litters	% av kull % of litters	Levendefødte Live born	Dødfødte Stillborn	Avvente Weaned
1	27,061	34.8	14.2	0.8	13.4
2	18,487	23.8	15.8	0.9	14.2
3	13,087	16.8	16.9	1.2	14.2
4	8,931	11.5	17.1	1.5	13.9
5	5,617	7.2	16.8	1.7	13.7
6	2,793	3.6	16.5	1.7	13.4
7	1,112	1.4	15.9	1.7	13.1
8	370	0.5	15.2	1.9	12.6
9	137	0.2	14.8	2.0	12.0
10	51	0.1	12.7	3.0	11.3

Farrowing environment

Crates Temporary Crates Pens Grouphousing Outdoor













Kirsty L. Chidgey, Patrick C.H. Morel, Kevin J. Stafford, Ian W. Barugh, 2016. The performance and behaviour of gilts and their piglets is influenced by whether they were born and reared in farrowing crates or farrowing pens. Livestock Science, 93, 51-57, https://doi.org/10.1016/j.livsci.2016.09.011.

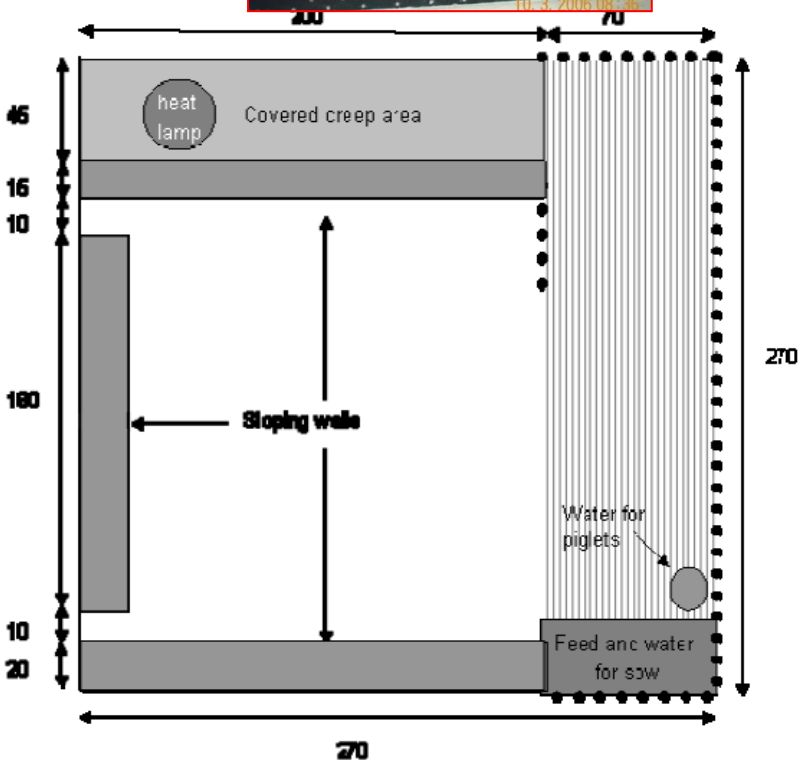
Guro Vasdal, Marit Glærum, Michala Melišová, Knut E. Bøe, Donald M. Broom, Inger Lise Andersen, 2010. Increasing the piglets' use of the creep area—A battle against biology? Applied Animal Behaviour Science, 125, 96-102, https://doi.org/10.1016/j.applanim.2010.04.010.

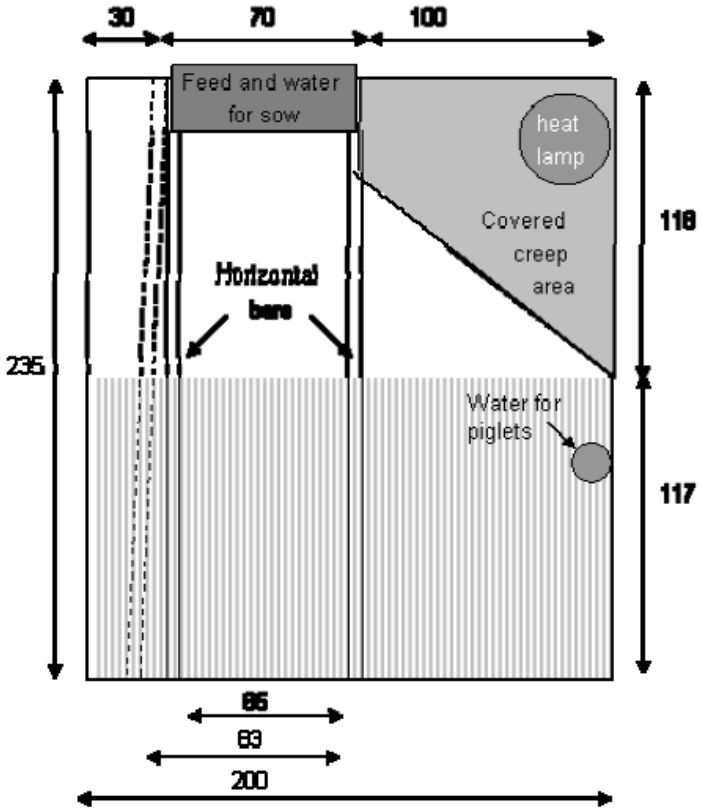
Comparing pens and crates

7.3 m ^{2}



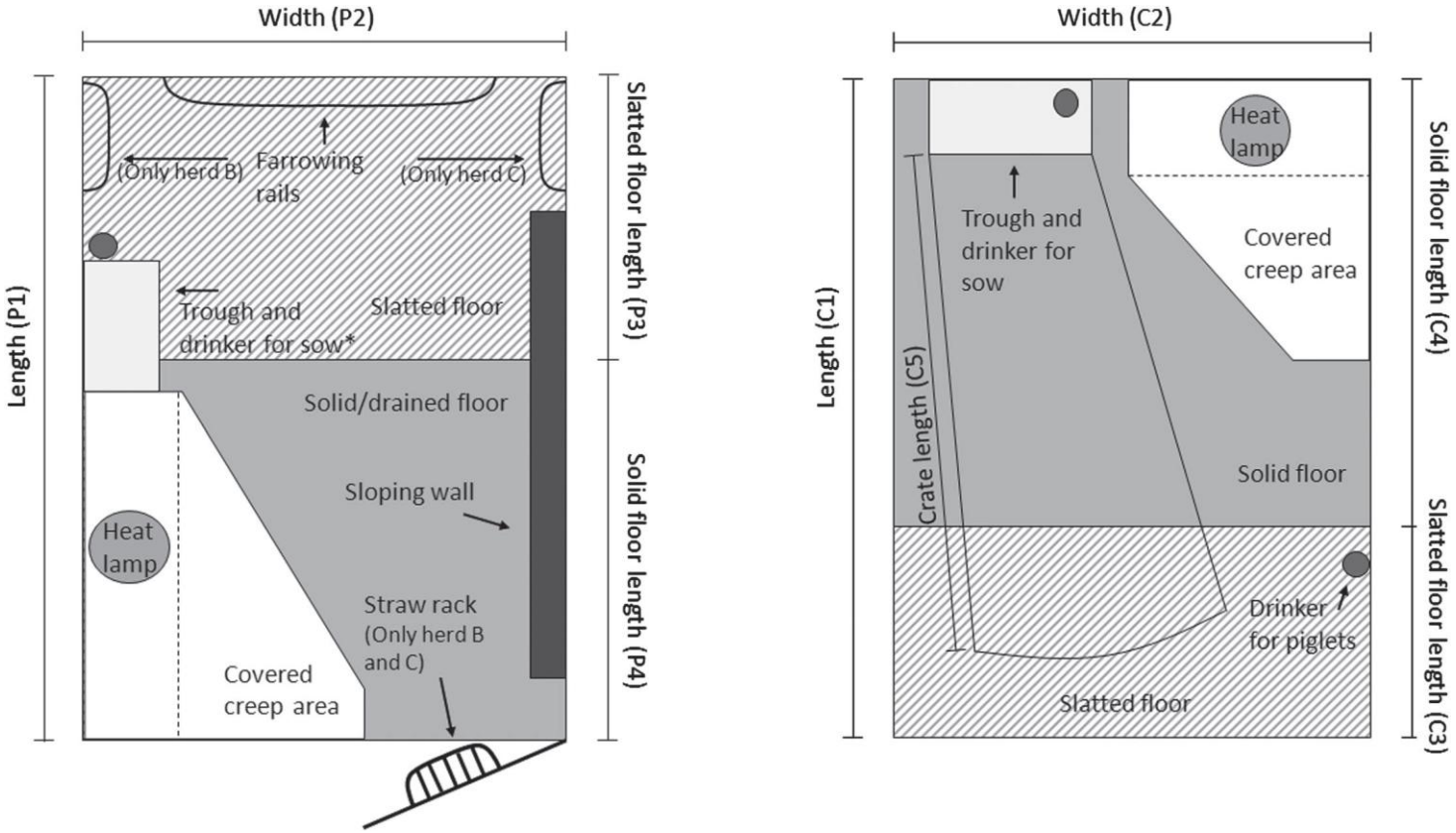






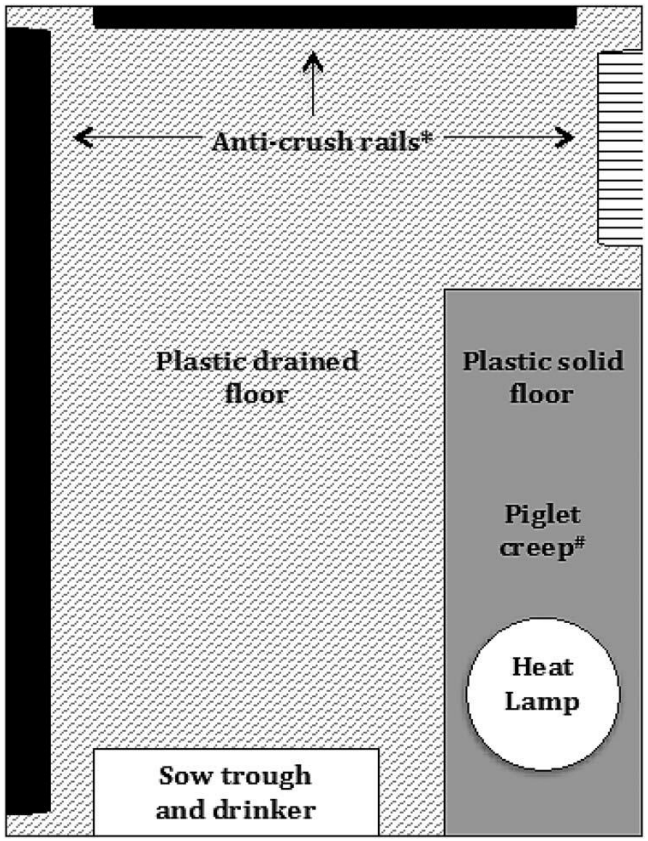
Pedersen LJ, Berg P, Jørgensen G, Andersen IL., 2011 Neonatal piglet traits of importance for survival in crates and indoor pens. J Anim Sci., Apr; 89 (4):1207-18. doi: 10.2527/jas.2010-3248.

Crates vs. pens

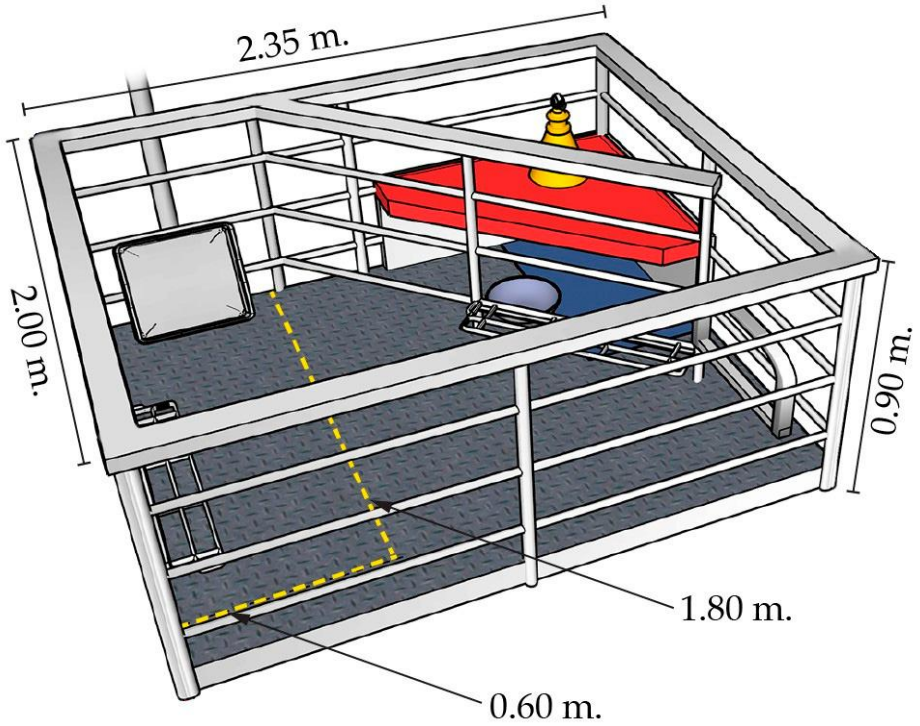


J. Hales, V.A. Moustsen, M.B.F. Nielsen, C.F. Hansen, 2014. Higher preweaning mortality in free farrowing pens compared with farrowing crates in three commercial pig farms, Animal, Volume 8, Issue 1, Pages 113-120, https://doi.org/10.1017/S1751731113001869.

Crates vs pens



C. Singh, M. Verdon, G.M. Cronin, P.H. Hemsworth, 2017. The behaviour and welfare of sows and piglets in farrowing crates or lactation pens, Animal, Volume 11, Issue 7, Pages 1210-1221, https://doi.org/10.1017/S1751731116002573.



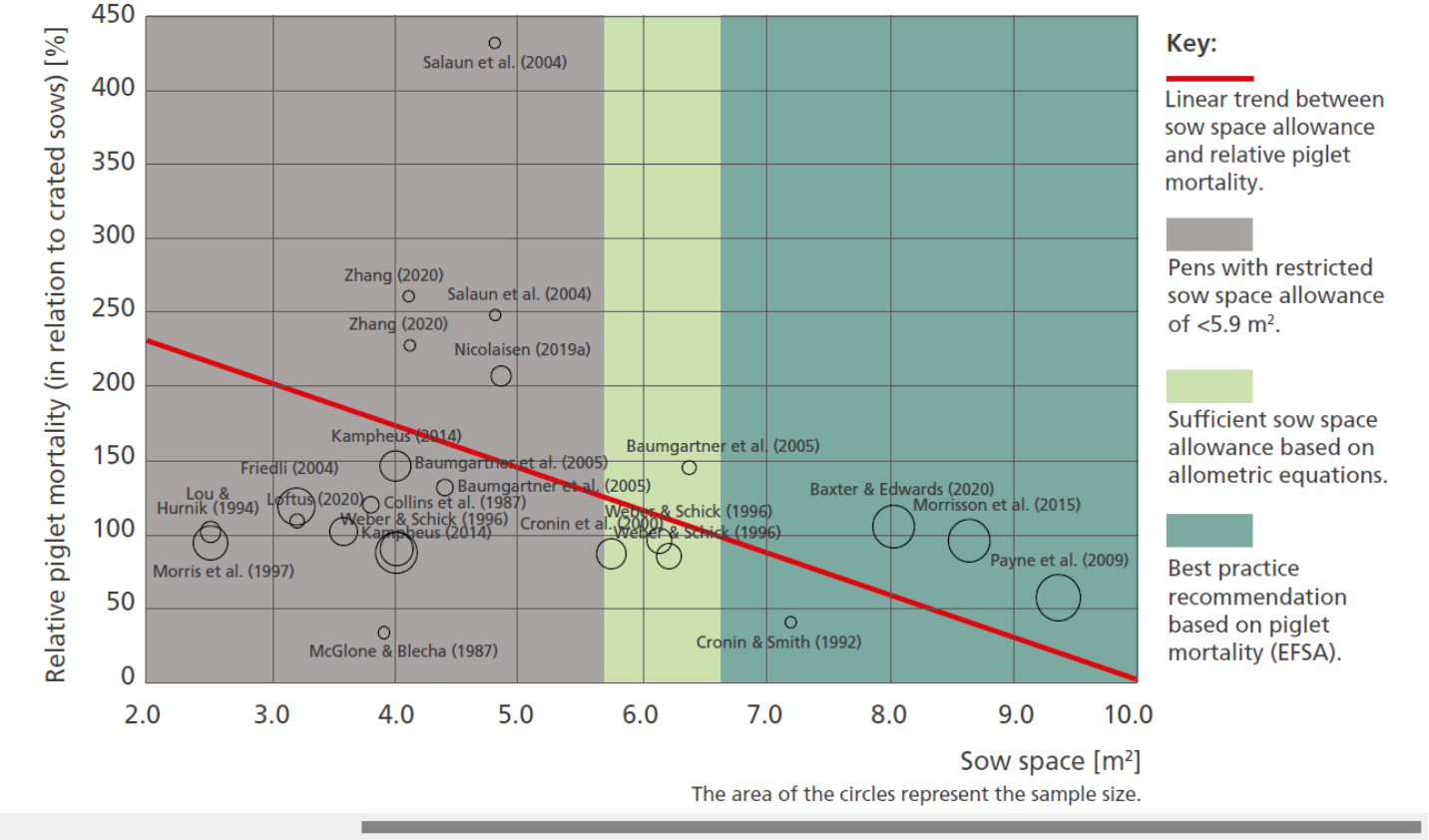
Dumniem, N.; Boonprakob, R.; Parsons, T.D.; Tummaruk, P., 2023 Pen Versus Crate: A Comparative Study on the Effects of Different Farrowing Systems on Farrowing Performance, Colostrum Yield and Piglet Preweaning Mortality in Sows under Tropical Conditions. *Animals*, *13*, 233. https://doi.org/10.3390/ani13020233

Crates vs. pens – meta-analysis; Glencorse et al., 2019:

- The first systematic review and meta-analysis conducted on the performance
- of farrowing accommodation, and identified that farrowing pens do compromise post-natal piglet
- There was a 14% increase in the relative risk of piglet mortality in farrowing
- pens when they were compared with crates.
- Future efforts should focus on improving sow comfort in the farrowing crate to maximize both piglet and sow welfare.
- 380 publications in the meta-analysis; out of those , only 7 publications were with pens that were 7 m^2 or larger

Glencorse, D.; Plush, K.; Hazel, S.; D'Souza, D.; Hebart, M., 2019. Impact of Non-Confinement Accommodation on Farrowing Performance: A Systematic Review and Meta-Analysis of Farrowing Crates Versus Pens. *Animals*, *9*, 957. https://doi.org/10.3390/ani9110957

EFSA (2022) Welfare of pigs on farm; pen size.



Larger pens with more bedding material, solid walls in the resting area and not the least with a deeper slatted floor area with open walls results in a better dunging pattern and the cleanest pens:

Bøe, K. E., Hall, E. J. S. & Cronin, G. M., 2019. The effect of pen design on pen floor cleanliness in farrowing pens for loose housed lactating sows. Livest. Sci., 229, 37-42, 2019.

Crates or pens? Swiss pens, FAT1 and FAT 2



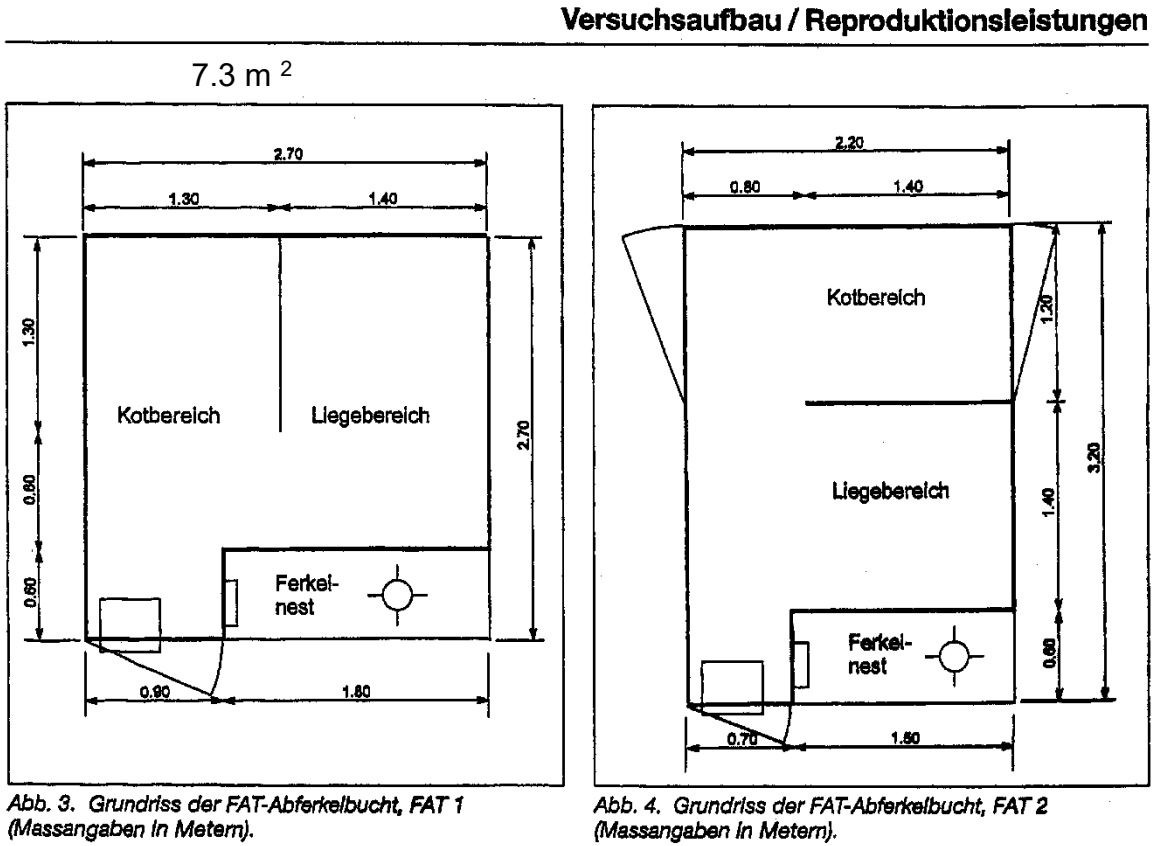


Abb. 3. Grundriss der FAT-Abferkelbucht, FAT 1 (Massangaben in Metern).

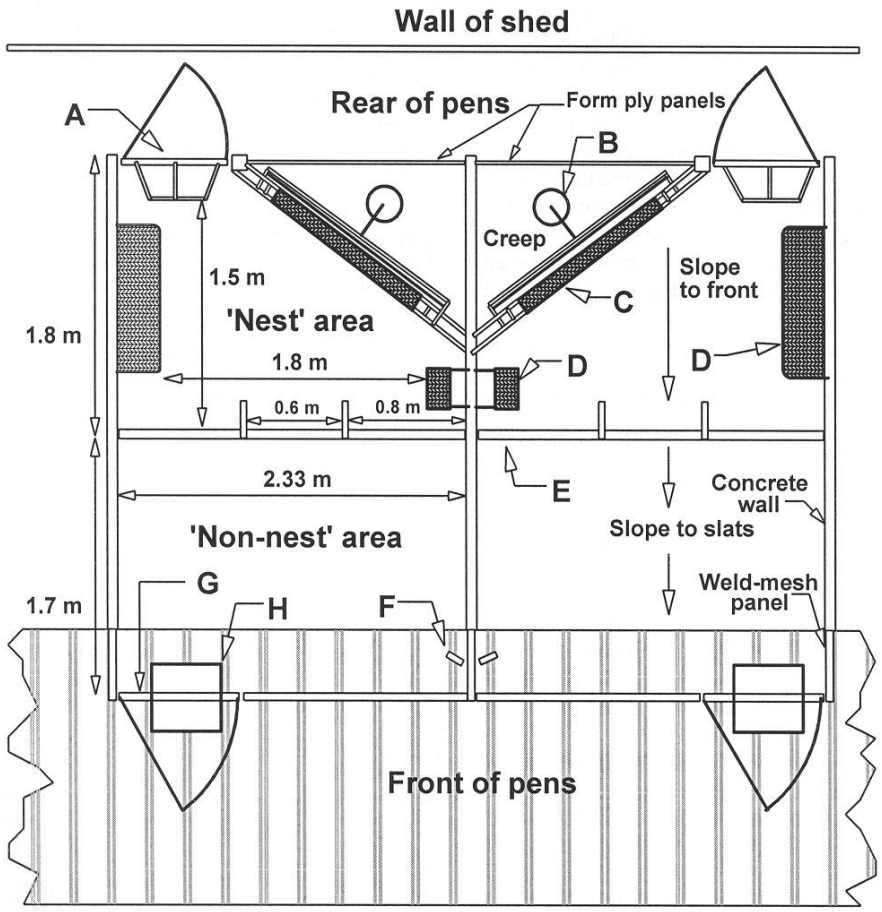
Abb. 4. Grundriss der FAT-Abferkelbucht, FAT 2 (Massangaben in Metern).

Weber, R., Keil, N.M., Fehr, M. & Horat, R., 2007. Piglet mortality on farms using farrowing systems with or without crates. *Anim. Welfare*, 16, 277–279.

Weber, R., Keil, N.M., Fehr, M., Horat, R., 2009. Factors affecting piglet mortality in loose farrowing systems on commercial farms. *Livest. Sci.,* 124, 216-222, 2009.

Crates or pens? Werribee farrowing pen from Australia, Cronin, 1997-2000

Total space: 8,2 m^2

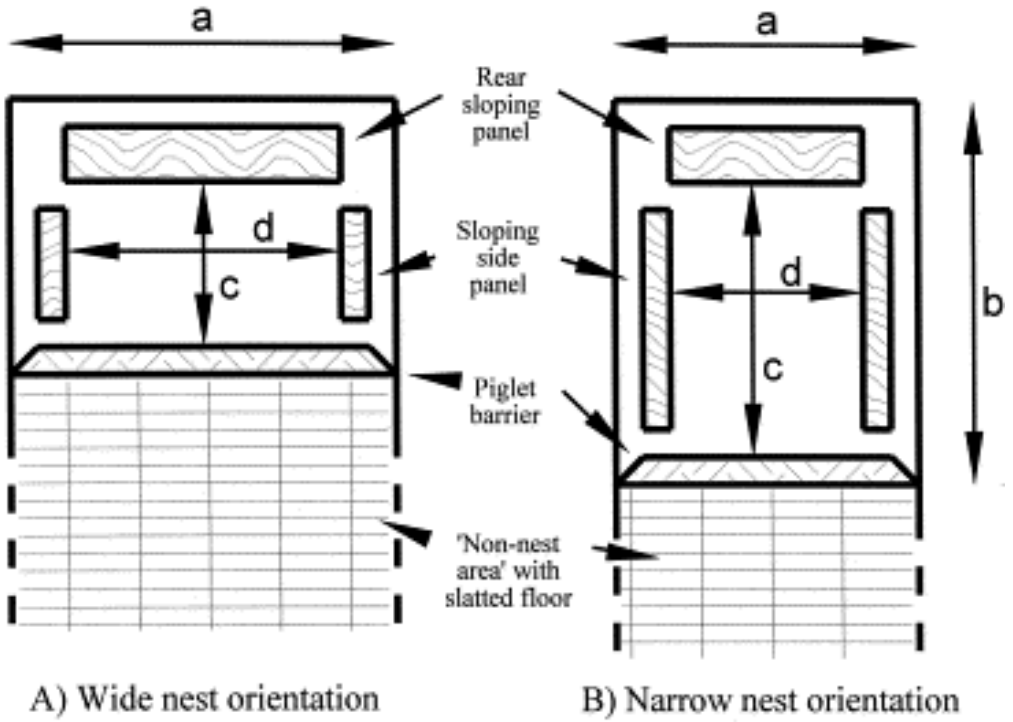


Cronin, G.M. Practical Alternatives for farrowing sows. *Pig research Report*, Dep. of Natural Resources and Environment, Agriculture Victoria. 82 p, 1997a.

Cronin, G.M., Leeson E. & Dunsmore B.W.N. Sow preference for farrowing site orientation. Manipulating Pig Production VI, Ed. P.D. Cranwell, *Australasian Pig Science Association*, Werribee, p. 63, 1997b.

Crates or pens? Wide vs. narrow nest area (Cronin, 1997)

a=2.0-2.4 m



a=1.7-1.8 m

90,5 % of the piglets survived until weaning when a wide nest was used, whereas only 83 % of the piglets survived in the narrow nest

The sows had less vocal communication with the piglets at the time of nursing in the narrow nest

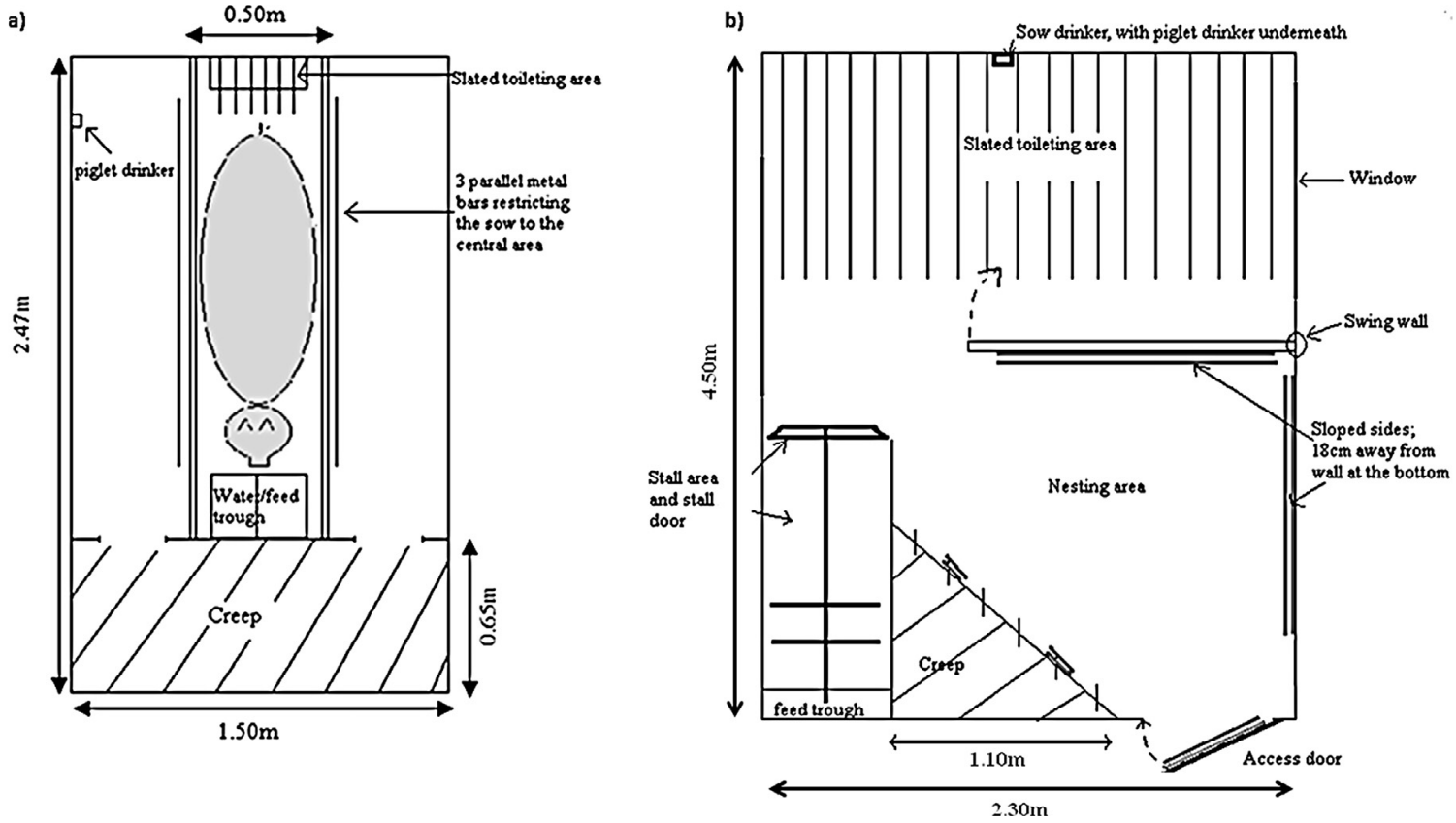
70 % more posture changes in the narrow nest

Piglets suckled 60 % less frequently in the narrow nest

Cronin, G.M., Dunsmore B. & Leeson E., 1998. The effects of farrowing nest size and width on sow and piglet behaviour and piglet survival. *Appl. Anim. Behav. Sci.,* 60, 331-345.

Cronin, G.M., Lefébure, B. & McClintock S., 2000. A comparison of piglet production and survival in the Werribee Farrowing Pen and conventional farrowing crates at a commercial farm. *Australian Journal of Experimental Agriculture,* 40, 17–23.

Crates vs. pens (PigSafe) Consequences for postnatal behavioural development



Jessica E. Martin, Sarah H. Ison, Emma M. Baxter, 2015. The influence of neonatal environment on piglet play behaviour and post-weaning social and cognitive development, Applied Animal Behaviour Science, Volume 163, Pages 69-79, https://doi.org/10.1016/j.applanim.2014.11.022.

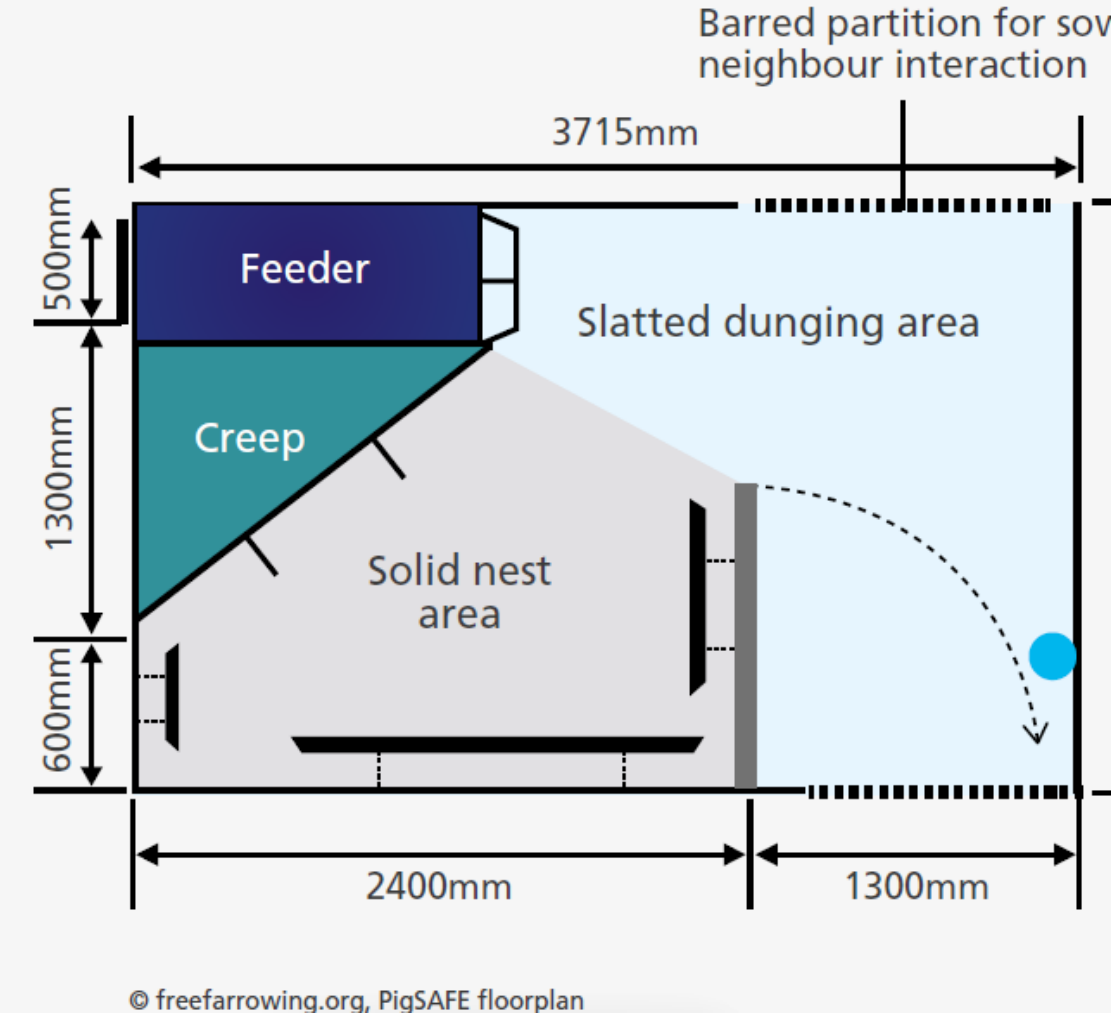
Temporary crating (Goumon et al., 2022):

- Increased exploration and interactions with piglets when not permanently crated.
- Uncertain whether the observed short-term benefits translate to other welfare indicators
- No reduction in the frequency of stereotypies or body lesions and do not provide a clear answer regarding sow stress response when released from confinement
- TC appears beneficial for reducing piglet mortality
- The impact of the time of onset of TC on the farrowing process and piglet mortality have been inconsistent
- Confining the sow briefly after farrowing may be the best compromise, allowing the sow to perform motivated nest-building behavior, but the risks of crushing during the unconfined farrowing period may increase.
- Piglet mortality was higher in the post-opening than pre-opening period

Me: Is TC really a step forward to better pig welfare compared to the farrowing crate??

Goumon S, Illmann G, Moustsen VA, Baxter EM and Edwards SA (2022). Review of Temporary Crating ofFarrowing and Lactating Sows. Front. Vet. Sci. 9:811810. doi: 10.3389/fvets.2022.811810

The Pigsafe pen



8.5 m2



Emma M. Baxter, Oluwagbemiga O. Adeleye, Mhairi C. Jack, Marianne Farish, Sarah H. Ison, Sandra A. Edwards, 2015. Achieving optimum performance in a loose-housed farrowing system for sows: The effects of space and temperature, Applied Animal Behaviour Science, 169, 9-16, https://doi.org/10.1016/j.applanim.2015.05.004.



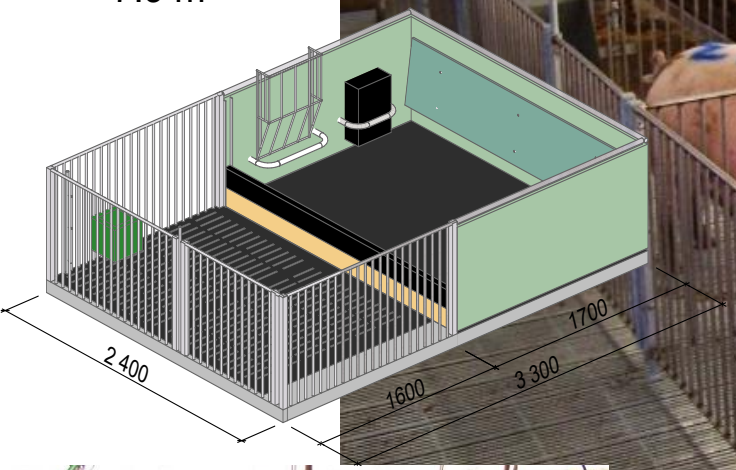








7.9 m 2

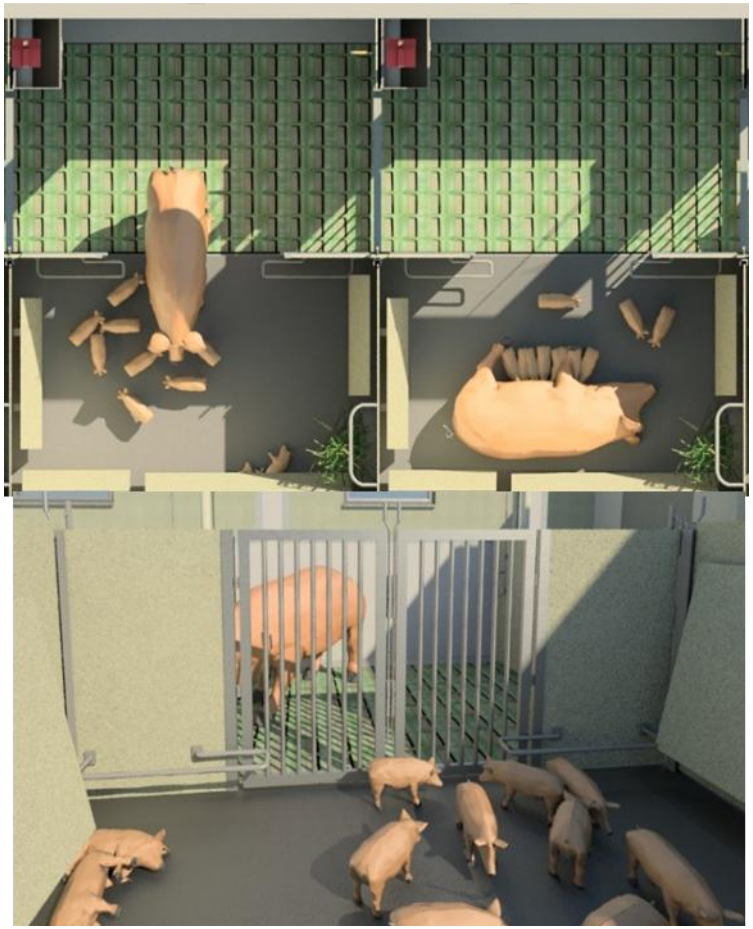


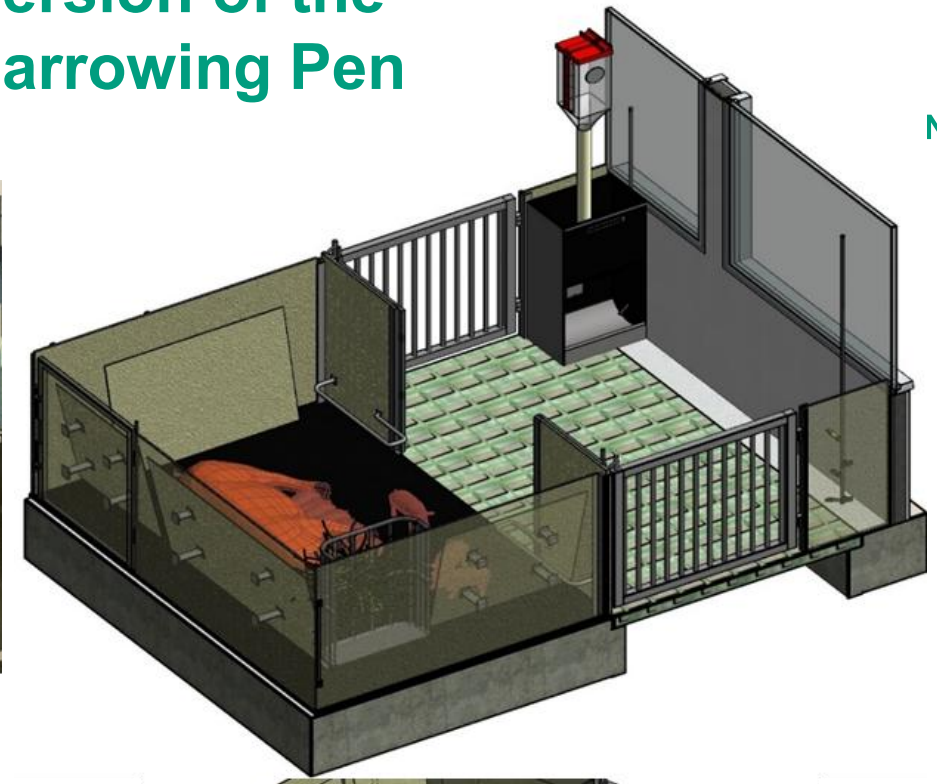


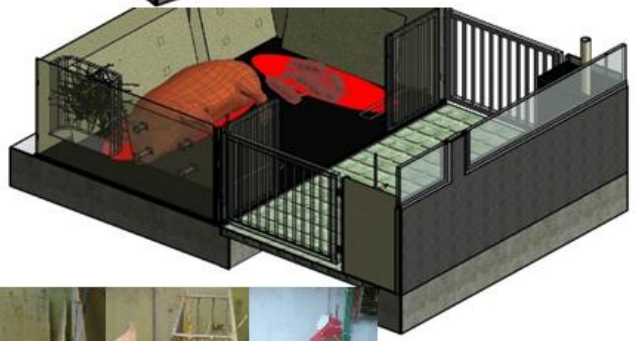
The SowComfortFarrowing Pen
First pilot version tested
in Norway and Australia



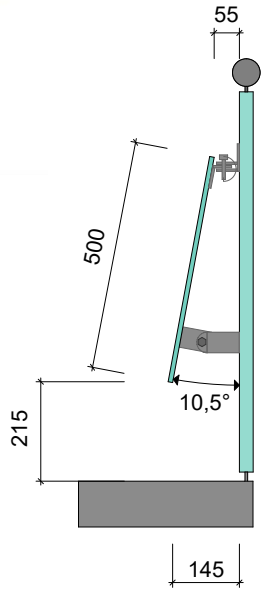
Commercial version of the SowComfortFarrowing Pen



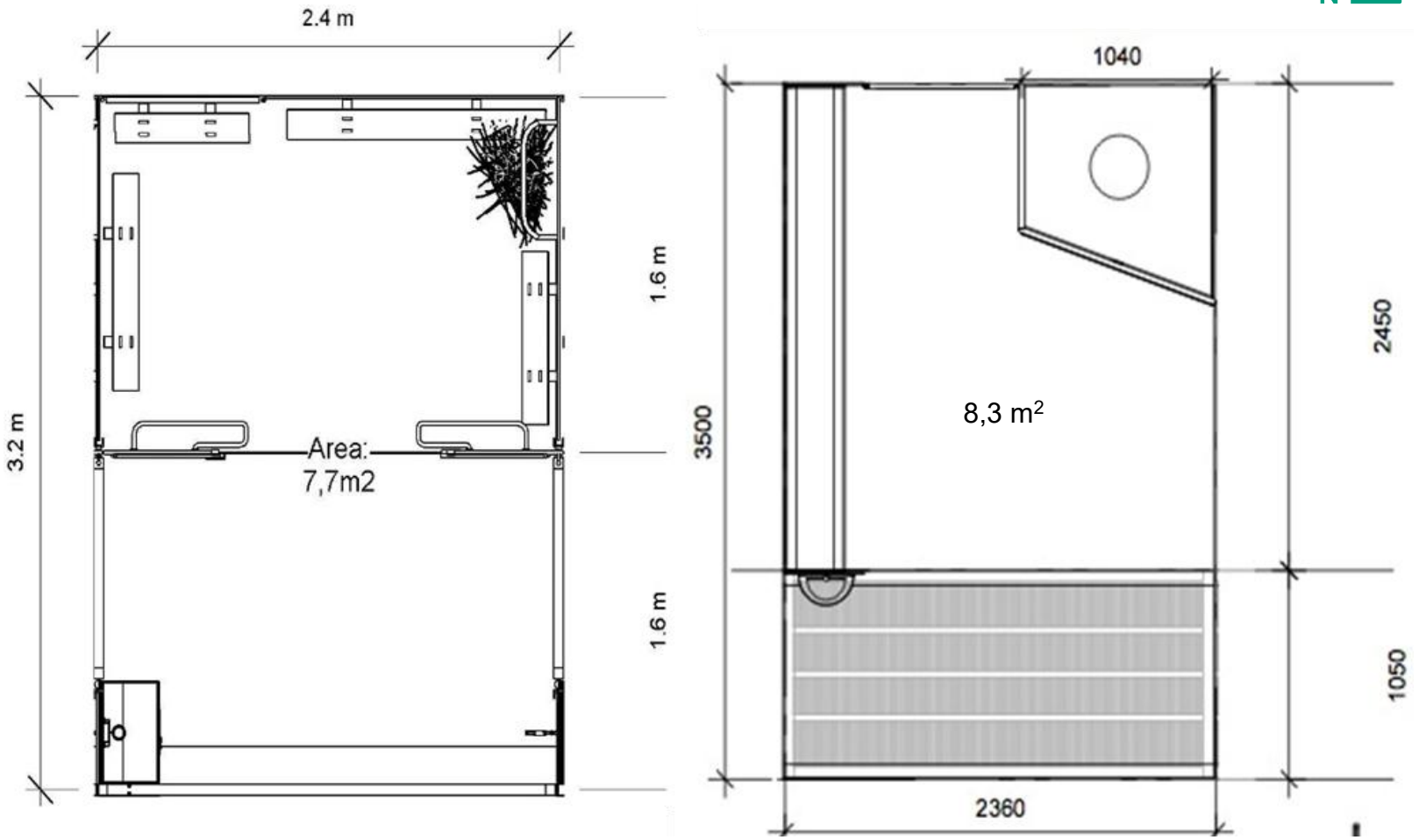








Comparison between traditional pen type vs SOWCOMF in 2 commercial farms

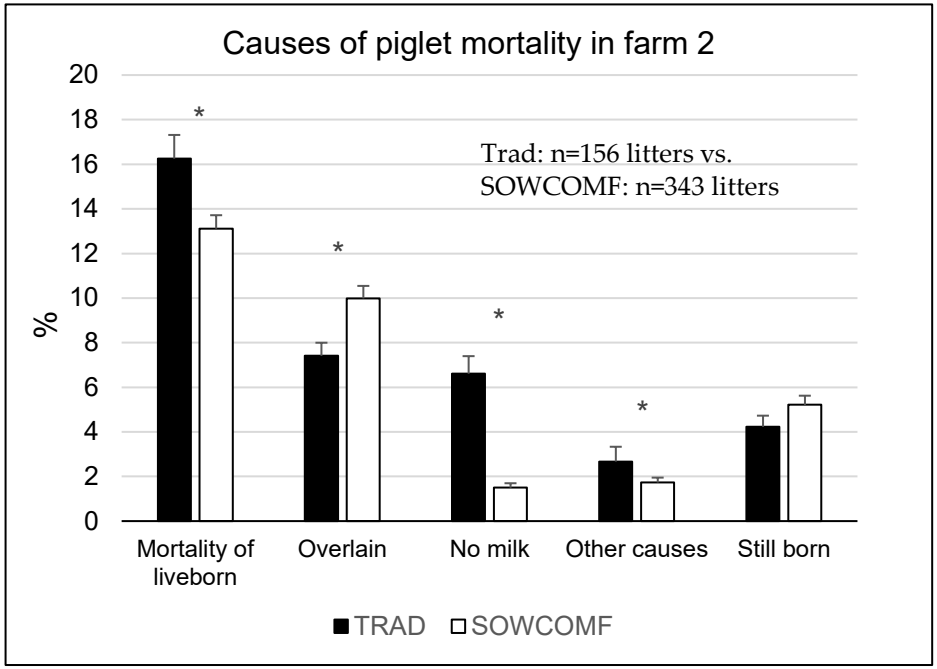


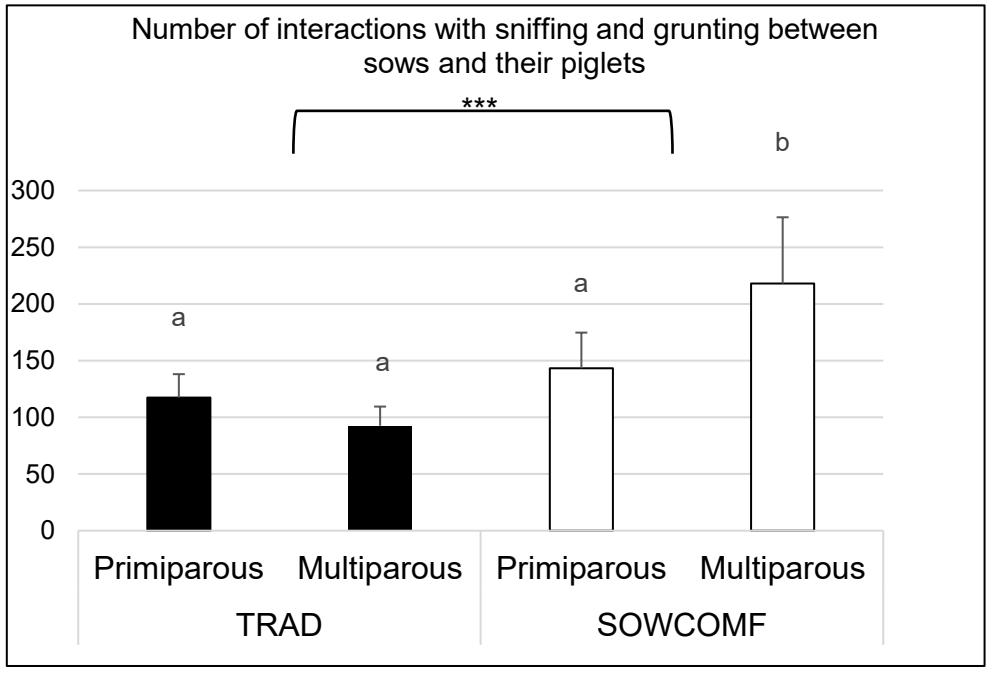
Andersen, I.L.; Ocepek, M. Farrowing Pens for Individually Loose-Housed Sows: Results on the Development of the SowComfort Farrowing Pen. Agriculture 2022, 12, 868. https://doi.org/10.3390/agriculture12060868

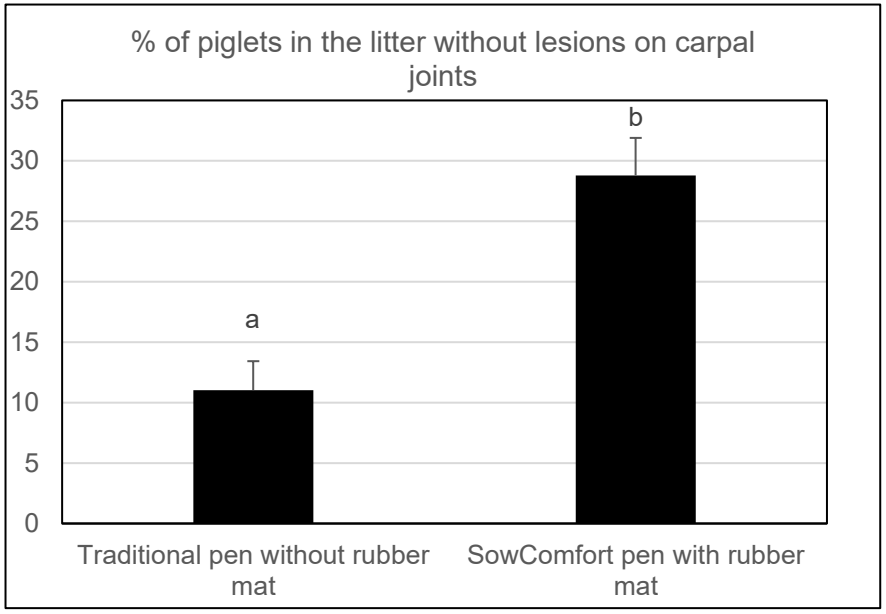
Results from commercial farms on the SowComfort pen

2 separate farms testing the same pens show similar results.

In the second farm mortality of live born piglets was reduced from more than 15% in the 1st batch to less than 12% in the 7th batch.







From birth until 30 kg or from birth until slaughter (Fjøssystemer A/S)



Slightly changed version of the SowComfort farrowing pen into a "from-farrowing- to-30 kg" pen (May Helen Gryte, Fjøssystemer A/S 2019).





Group housing of lactating sows



S.E. van Nieuwamerongen, J.E. Bolhuis, C.M.C. van der Peet-Schwering, N.M. Soede, 2014. A review of sow and piglet behaviour and performance in group housing systems for lactating sows, Animal,Volume 8, Issue 3, Pages 448-460, https://doi.org/10.1017/S1751731113002280.

M. Verdon, R. S. Morrison, P. H. Hemsworth, 2016. Rearing piglets in multi-litter group lactation systems: Effects on piglet aggression and injuries post-weaning, Applied Animal Behaviour Science, Volume 183, Pages 35-41, https://doi.org/10.1016/j.applanim.2016.05.008

To sum up: back to answering the initial questions….

What kind of animal or biological system are we designing an environment for?

What are the basic behavioural needs of the sow at farrowing and lactation, and how can we stimulate her to become a good mother?

How can we create an environment where the sow is confident, relaxed and attentive towards her young?

What factors are important for the farmer to have good working conditions and a good relationship to his pigs?



