Free farrowing systems

Commercial farrowing systems predominantly operate indoor confinement crates or outdoor arks, which represent the two extremes of sow restraint, substrate provision and environmental control. Both systems perform similarly with regards to mortality of piglets born alive, averaging 12.30% and 12.85%, respectively (BPEX, 2009). Approximately 92% of sows in 14 European countries were farrowing in crates by the late 1990's (Hendriks et al., 1998); the system raises welfare issues for both sows and piglets, and there is growing pressure for discontinuing its use (RSPCA, 2011; CIWF 2006). Realistic estimates suggest 25% the UK national herd are kept outdoors (BPEX, 2008), whereas in France, less than 1% of pig production is outdoors (Ifip, 2011). Indoor, commercially viable alternatives to the confinement crate are required. Despite many years of research into alternative farrowing systems, and some success with Schmid pens (Weber et al., 2007), clear recommendations for commercially viable alternatives have been limited, until recently (Baxter et al., 2011; Edwards and Baxter, 2010).

Piglet mortality to date in free farrowing systems

Piglet survival is paramount for good welfare and economic viability; a 1% increase in mortality reduces labour income by 12% and a 1% increase in cost of production may reduce income by 30-50% (Anon 1997). Alternatives to the farrowing crate must therefore have comparable performance to the farrowing crate for piglet mortality in order to be adopted.

Experimental studies in the '90's and early 2000's began to centre on individual pens with or without the provision of straw, and kennels, crates that open, or basic nest areas; piglet mortality (as a percent of liveborn) ranged from 15-25% (for instance Marchant, 1997; Marchant et al., 2000; Jones et al., 2003; Damm et al., 2005a) and was generally higher than in crated comparisons. Weber et al (2007), however, reported Swiss commercial data for losses in farrowing pens (>5m^2, from 173 farms) were similar to those in crates (482 farms), at 12.7%. There were more crushed piglets in loose systems (0.62 versus 0.52 piglets per litter) but litter size at birth was the main influence on mortality. Sow age in loose pens was also implicated with higher mortality (Weber et al., 2009), whilst lower mortality was associated with use of farrowing rails on all sides of the pen, litter in the sow area during farrowing and assistance provided for piglets to obtain colostrum (Anderson et al., 2007).

Recent data from the 'PigSAFE' system at one site in the UK, indicates pre-weaning mortality (as percent of live-born) in the prototype system is not different from that in crates (6.4% PigSAFE, 7.5% crates) (Edwards et al., 2011).

Pedersen et al (2011a) investigated the odds of piglets from two distinct genetic groups (high versus low piglet survival at day 5) dying from various causes in two farrowing systems; pen (7.4m^2, 2kg of chopped straw daily) or crate (4.7m^2, 1kg chopped straw daily). There were no significant effects of genetic group on any category of mortality, which averaged 18.2% of total number born, or effect of housing on the odds of piglets being stillborn, crushed or dying of starvation. Birth weight, body temperature 2h after birth and length of birth process were all important in determining the risk of crushing, starvation or disease, suggesting that the same traits were important for survival in both housing systems; adapting the management to suit alternative systems is therefore key to their success. Key factors for piglet survival and for the welfare provision of sows and piglets are discussed below.

Nest building and parturition

Sows have an in-built behavioural need to nest build which has survived domestication, and involves searching for nest material, digging and rooting out a shallow hollow, and construction of a suitable nest (see Wechsler and Weber, 2007; Wischner et al., 2009; Baxter et al., 2010, for full details). Fulfilment of this behaviour triggers a rise in oxytocin levels and the sow becomes inactive ready for parturition.

Despite elements of the nest building behaviour (biting and rooting at pen fittings and the floor) being present in farrowing crates, fulfilment is not satisfactory, and the phase lasted longer than in pens with straw (Damm et al., 2003; Wischner et al, 2009). Poor quality environmental feedback leads to reduced oxytocin levels and longer parturition times for sows in crates, leading to higher stillbirth rates and delayed colostrum release (Oliviero et al., 2008).

Termination of nest building in gilts was strongest with the provision of branches as well as straw bedding, which allowed the construction of more structured nests (Damm et al., 2000). In practice, long straw was more effective at switching off nest building activity than short straw (Burri et al., 2009); Edwards and Baxter (2010) recommend a minimum of 2kg of long straw be provided pre-partum.

Maximising maternal behaviour

Maternal behaviour from the onset of farrowing until weaning is of great importance, mainly as it affects piglet mortality. Ideally, once parturition begins, the sow enters a period of prolonged lateral lying and udder exposure, with short periods of standing to make nose-to-nose contact with her piglets. By 30 hours post partum, colostrum production (by the sow) and absorption (by the piglet gut) have ceased, so frequent nursing bouts (every 30-70 minutes) are vital. This is a risky time for piglets, especially those who are small, cold or weak as they must move to the udder while avoiding being crushed by the sow. Maximising maternal behaviour by providing the right physical and thermal environment for the sow is key, whilst selection for maternal behaviour will play an important role in the future (Thordberg et al., 2002a; Baxter et al., 2011).

The transition from standing to lying was the most common cause of crushing in both indoor loose-housed and outdoor farrowing (Baxter et al., 2011). The care and control taken by a sow as she lies down and during her postural changes whilst lying down are key to piglet survival in any system. “Non-crushing” mothers were observed to spend more time making nose-to-nose contact with their piglets before lying down, as well as reacting more quickly to piglet distress calls (Andersen et al., (2005) cited Baxter et al., 2010). A high “carefulness score” (based on the length of time spent sniffing, rooting and pawing the floor prior to lying down in octagonal “walk around” crates with straw), was associated with a lower risk of crushing (Pokorna et al., 2008). Conversely, a high frequency of postural changes between the birth of the first and third piglets and a high frequency of rolling from sternal to lateral recumbency during farrowing, increased the risk of crushing (Thodberg et al., 2002b), as did lying down quickly, or laterally without leaning against a wall, or when the piglets were scattered around the sow (Burri et al., 2009). Gilts were more reactive to recordings of piglet distress calls in loose pens compared to crates (Nowicki and Schwarz 2010) indicating a positive effect of loose systems on maternal behaviour.

Successful nursing bouts are also key to piglet survival. Sows in pens had longer milk let down and terminated fewer suckling bouts than sows in crates (Dyjbaer et al., 2001; Devillers and Farmer, 2008; Litschauer et al., 2006; Pederson et al., 2011b), giving piglets the best chance to thrive.

Provision of a suitable thermal environment

The farrowing environment must provide a suitable thermal micro-climate for piglet survivability particularly in the first 48-72 hours, as newly-born piglets are wet, cannot thermoregulate and have no active immunity. They need to dry off, warm up and ingest cholesterol as soon as possible.

Free living sows (or sows in a semi-naturalistic environment) regulate the micro-climate for their young by adapting their nest construction (usually the amount of bedding material) to suit the environmental conditions (Jensen, 1989), and are able to maintain average nest temperatures of 20^{o}C at low ambient temperatures (Alger and Jensen, 1990). Outdoor commercial free-farrowing sows are also able to maintain hut temperatures between 21 and 24^{o}C (Johnson and McGlone, 2003), and temperature within the deep straw bedding of 31.5^{o}C when temperature in the hut is below 15^{o}C (Baxter et al, 2009). Heat lamps in the creep area and heated floors warm piglets immediately after birth and help to reduce mortality (Andersen et al., 2007; Malmkvist et al., 2006).

Farrowing houses are generally kept at ambient temperatures of 18-23^{o} C, as heat stress of the sow can lead to reduced feed intake and milk output. However, in the first days post partum intensively reared sows choose resting areas with a floor temperature of 34^{o}C (Phillips et al., 2000; Pederson et al., 2007), before gradually moving to a floor of 22^{o}C. High floor temperature encouraged the sow to make fewer postural changes and piglets to gradually spend more time away from the sow (Pederson et al., 2007), so reducing the risk of crushing; additionally, the sows were not stressed by high floor temperatures (Malmkvist et al., 2006). Given the opportunity, this ability of the sow to choose or create a warm micro-climate well above her thermoneutral comfort zone (~18-20^{o}C) allows her to provide for a neonate who's lower critical temperature is much higher than her own (~34^{o}C), and is key to early survival.

For thermal comfort of piglets during parturition, a bedding depth of 10-12 cm is recommended, depending on floor properties and ambient temperature (Baxter et al., 2010). From 24 hours post-farrowing this can be reduced to provide small amounts of recreational chopped straw or sawdust.

As lactation continues, consideration should be given to methods of cooling the sow in order to maintain feed intake and milk output. Concrete floors had better heat conduction than either plastic or cast iron flooring (Pedersen and Ravn, 2008), while floor cooling systems increased nursing time, feed intake and piglet weight gain (Silva et al., 2009); evaporative cooling in hot climates is recommended (Huynh et al 2007).

Provision of solid flooring

Perforated floors led to a higher incidence of leg abrasions and teat cuts than either solid concrete or straw-based flooring (Edwards and Lightfoot, 1986), and sows in farrowing crates preferred solid concrete flooring to plastic rod and galvanised metal rod flooring (Philips et al., 1996). More recently, cast iron slatted floors were implicated in MMA incidence and increased piglet mortality by 4-5% (Hoy, 2004), and slatted steel floors with increased limb injuries in piglets (Lewis et al., 2005). Zoric et al (2008) found higher rates of lameness in sows on partially or fully slatted concrete or metal slats than solid concrete floors, but skin abrasions and toe horn removal were more prevalent on concrete floors. Finally, sow transitions from standing to sitting or lying occurred more quickly on slatted metal floors than when provided with lying mats (Boyle et al., 2000; Damm et al., 2005b), probably due to the discomfort of kneeling on a metal slatted floor, increasing the risk of piglet crushing.

Solid floors are therefore recommended in the nest area, with a slatted floor in the dunging area for the removal of faeces and maintenance of hygiene. Void widths of 10mm or less with rounded edges are recommended (Baxter et al., 2010).

Provision of adequate space in the farrowing pen

The space provided in a farrowing pen is considered a major factor hindering maternal behaviour, more so than straw provision (Jarvis et al., 2002). Whilst Swiss Schmidt pens provide space allowances of between 5.1 and 8.6m^2 (Weber et al., 2009), Schmid (1991) considered the minimum pen size should be 7.5m^2, divided roughly equally between nest and activity area.

When Baxter et al (2010) used allometric equations to estimate the space requirements of a pen which included a nest area, separate feed area, space for suckling piglets to grow, and a creep area, they calculated a total pen area of 9.75m^2. The space requirements for new builds of the PigSAFE pen subsequently recommend a pen area of 9m^2 (Edwards and Baxter, 2010), although trials with refurbished pens of 7.7m^2 are proving successful (Edwards et al., 2011).

Other important aspects of farrowing pen design and layout

The following aspects were also recommended by Baxter et al (2010) in their review of farrowing systems design: **Enclosure:** Sows prefer nest sites inside, or against a solid wall (Stolba and Wood-Gush, 1984); having three solid sides can provide this under commercial conditions and the nest area should not be brightly lit. **Sloping walls**: These provide the sow with support which allows her to lie down more slowly and carefully and are preferred over farrowing rails (Damm et al., 2006). Piglets can lie in the area between the sloping and vertical wall which protects them from the sow and should be available at all pen walls. **Lactational mixing of sows and piglets**: is best avoided. **Environmental enrichment for piglets**: Provision of foraging materials such as peat could reduce aggression and behaviours such as belly nosing. Piglets should be provided with an upward angled nipple drinker in the slatted area.

Summary

In practice, producers developing indoor free-farrowing systems need to consider key aspects of design and management to maximise piglet survival and enhance the welfare of sows and piglets. These include: provision of sufficient space, solid floors with long straw bedding in the nest area, optimal physical and thermal environment to maximise maternal behaviour, key design elements highlighted here and importantly an attitudinal shift to the operation of the system.

References

Algers, B., and Jensen, P. (1990) Thermal Microclimate in Winter Farrowing Nests of Free-ranging Domestic Pigs Livestock Production Science, 25 177-181 177

Andersen, I.L., Berg , S. And Boe, K.E. (2005) Crushing of piglets by the mother sow (Sus scrofa) – purely accidental or a poor mother? Applied Animal Behaviour Science 93: 229-243

Andersen, I.L., Tajet, G.M., Haukvik, I.A., Kongsrud, S. And Boe, K.E. (2007) Relationship between postnatal piglet mortality, environmental factors and management around farrowing in herds with loose-housed lactating sows. Acta Agriculturae Scandanavica Section A: 57: 38-45

Baxter, E.M., Jarvis, S., Sherwood, L., Robson, S.K., Ormandy, E., Farish, M., Smurthwaite, K.M., Roehe, R., Lawrence, A.B. and Edwards, S.A. (2009) Indicators of piglet survival in an outdoor farrowing system. Livestock Science 124: 266-276

Baxter, E.M., Lawrence, A.B. and Edwards, S.A. (2010) Alternative farrowing systems: design criteria for farrowing systems based on the biological needs of sows and piglets. Animal 5(4): 580-600

Baxter, E.M., Jarvis, S., Sherwood, L., Farish, M., Roehe, R., Lawrence, A.B. and Edwards, S.A. (2011) Genetic and environmental effects on piglet survival and maternal behaviour of the farrowing sow. Applied Animal Behaviour Science 130: 28-41

Boyle, L.A., Regan, D., Leonard, F.C., Lynch, P.B. and Brophy, P. (2000) 'The effect of mats on the welfare of sows and piglets in the farrowing house', Animal Welfare, **9**, 39 - 48.

BPEX (2008) Economic and Policy Analysis Group, Structure of the UK Pig Industry, 6. November 2008. Available at: http://www.bpex.org/downloads/297271/288141/Structure%20of%20the%20UK%20pig%20industry%20-%20feed.pdf

BPEX (2009) Pig Yearbook 2009. BPEX, Winterhill House, Snowdon Drive, Milton Keynes, MK6 1AX. ISBN 978-1-904437-39-0

Burri, M., Wechsler, B., Gyax, L. and Weber, R. (2009) Influence of straw length, sow behaviour and room temperature on the incidence of dangerous situations for piglets in a loose farrowing system. Applied Animal Behaviour Science 117: 181-189

Damm, B.I., Vestergaard, K.S., Schrøder-Petersen, D.L., and Ladewig, J. (2000) The effects of branches on prepartum nest building in gilts with access to straw. Applied Animal Behaviour Science 69(2): 113-124

Damm, B.I., Lisborg, L., Vestergaard, K.S., Vanicek, J. (2003) Nest-building, behavioural disturbances and heart rate in farrowing sows kept in crates and Schmid pens. Livestock Production Science 80: 175–187

Damm,B.I., Pedersen L.J., Heiskanen T., NielsenN.P. (2005a) Long-stemmed straw as an additional nesting material in modified Schmid pens in a commercial breeding unit: effects on sow behaviour, and on piglet mortality and growth Applied Animal Behaviour Science 92: 45–60

Damm, B.I., Forkman, B. and Pedersen, L.J. (2005b) 'Lying down and rolling behaviour in sows in relation to piglet crushing', Applied Animal Behaviour Science, 90, 3 – 20.

Damm, B.I., Moustsen, V., Jørgensen, E. Pedersen, L.J., Heiskanen, T., Forkman, B. (2006) Sow preferences for walls to lean against when lying down Applied Animal Behaviour Science 99: 53–63

Devillers, N. and Farmer, C. (2008) 'Effects of a new housing system and temperature on sow behaviour during lactation', Acta Agriculturae Scandinavica, Section A – Animal Sciences, 58, 55 - 60.

Dybjaer, L., Olsen, A. N. W., Miller, F. and Jensen, K. H. (2001) 'Effects of Farrowing Conditions on Behaviour in Multi-suckling Pens for Pigs', Acta Agriculturae Scandinavica, Section A – Animal Sciences, 51, 134 - 141.

Edwards, S.A. and Lightfoot, A. L. (1986) 'The effect of floor type in farrowing pens on pig injury. II. Leg and teat damage of sows', British Veterinary Journal, 142, 441 - 445.

Edwards, S.A. and Baxter E.M. (2010) The PigSAFE Project: Developing an alternative to the farrowing crate. Recommended dimensions and details for building PigSAFE pens. November 2010.

Edwards, S.A., Brett, M., Guy, J.H., and Baxter, E.M. (2011) Practical evaluation of an indoor free farrowing system: the PigSAFE pen. In: Proceedings of 62nd Annual Meeting EAAP, Stavanger 2011, Page 17

Hendriks, H.J.M., Pedersen, B.K., Vermeer, H.M. and Wittmann, M. (1998) Pig housing systems in Europe: Current distributions and trends. Pig News and Information 19: 97-104

Hoy, S. (2004) '9 Years of Data on MMA', Pig Progress, 20, 14 - 15.

Huynh, T.T.T., Aarnink, A.J.A., Heetkamp, M.J.W., Vestegen, M.W.A. and Kemp, B. (2007) 'Evaporative heat loss from group-housed growing pigs at high ambient temperatures', Journal of Thermal Biology, 32, 293 - 299.

Jarvis, S., Calvert, S.K., Stevensen, J., vanLeeuwen, N., Lawrence A.B. (2002) Pituitary-adrenal activation in pre-parturient pigs (Sus Scrofa) is associated with behavioural restriction due to lack of space rather than nesting substrate. Animal Welfare 11: 371-384.

Jensen, P. (1989) Nest Site Choice and Nest Building of Free-ranging Domestic Pigs Due to Farrow Applied Animal Behaviour Science, 22: 13-21 13

Johnson, A.K., and McGlone, J.J. (2003) Fender design and insulation of farrowing huts: Effects on performance of outdoor sows and piglets. Journal of Animal science 81: 955-964.

Jones, T.A., Hunter E.J., Johnson, P., Guise, J. (2003) Non-restraint farrowing systems: An industry approach. The Pig Journal 52: 124-133

Lewis, E., Boyle, L. A., O'Doherty, J. V., Brophy, P. and Lynch, P. B. (2005) 'The effect of floor type in farrowing crates on piglet welfare', Irish Journal of Agricultural and Food Research, 44, 69 - 81.

Litschauer, K., Haidn, B. and Auernhammer, H. (2006) Circular Crates for Farrowing Sows- Effects on Animal Behaviour [www document]. https://mediatum.ub.tum.de/doc/1534555/1534555.pdf (Accessed 28 February 2009).

Malmkvist, J., Pedersen, L.J., Damgaard, B.M., Thodberg, K., Jorgensen, E. And Labouriau, R. (2006) Does floor heating around parturition affect the vitality of piglets born to loose housed sows? Applied Animal Behaviour Science 99: 88-105

Marchant, J.N. (1997) Alternatives to confining the sow. University of Cambridge, Department of Clinical Veterinary Medicine, Madingly Road, Cambridge, CP3 0ES and ADAS Terrington, Terrington St Clement, Kings Lynn, Norfolk, PE34 4PW.

Marchant, J.N., Rudd, A.R., Mendl, M.T., Broom, D.M., Meredith, M,J., Corning, S., Simmins, P.J. (2000) Timing and causes of piglet mortality in alternative and conventional farrowing systems. Veterinary Record 147: 209-214.

Nowicki, J and Schwarz, T. (2010) Maternal responsiveness of sows housed in two farrowing environments measured in behavioural tests. Ann. Anim. Sci. 10(2): 179-186

Oliviero, C., Heinonen, M., Valros, A., Halli, O. and Peltoniema, O. A. T. (2008) 'Effect of the environment on the physiology of the sow during late pregnancy, farrowing and early lactation', Animal Reproduction Science, **105**, 365 – 377.

Pedersen, L.J., Malmkvist, J., and Jørgensen E. 2007 The use of a heated floor area by sows and piglets in farrowing pens Applied Animal Behaviour Science 103: 1–11

Pedersen, S. and Ravn, P. (2008) Characteristics of slatted floors in pig pens; friction, shock absorption, ammonia emission and heat conduction, Agricultural Engineering International: CIGR Ejournal, Manuscript BC 08 005.

Pedersen, L.J., Berg, P., Jorgensen, G. and Andersen, I.L. (2011a) Neonatal piglet traits of importance for survival in crates and indoor pens. Journal of Animal Science 89: 1207-1218

Pedersen, M.L., Mousten, V.A., Nielsen, M.B.F. and Kristensen, A.R. (2011b) Improved udder access prolongs duration of milk letdown and increases piglet weight gain. Livestock Science 140(1): 253-261

Phillips, P.A., Fraser. D. and Thompson, B. K. (1996) 'Sow preference for types of flooring in farrowing crates', Canadian Journal of Animal Science, 74, 485 - 489.

Phillips, P.A., Fraser D., and Pawluczuk B (2000) Floor temperature preference of sows at farrowing Applied Animal Behaviour Science 67: 59–65

Pokorna, Z., Illmann, G., Simeckova, M. Chaloupkova, H. And Kratinova, P. (2008) Carefulness and flexibility of lying down behaviour in sows during 24h post-partum in relation to piglet position. Applied Animal Behaviour Science 114: 346-358

Schmid H. (1991) A practical, behaviour specific housing system for farrowing and lactating sows. In: Alternatives in Animal husbandry. Proceedings of the International Conference. Eds. Boehncke, E. and Molke, N. Witzenhausen, July 22-25 1991.

Silva, B.A.N., Oliveira, R. F. M., Donzele, J. L., Fernandes, H. C., Lima, A. L., Renaudeau, D. and Noblet, J. (2009) 'Effect of floor cooling and dietary amino acids content on performance and behaviour of lactating primiparous sows during summer', Livestock Science, 120, 25 – 34.

Stolba, A., and Wood-Gush D.G.M (1984) The identification of behavioural key features and their incorporation into a housing design for pigs. Annales de Recherches Veterinaire 15: 287-299

Thodberg, K., Jensen, K.H. and Herskin, M.S (2002a) Nursing behaviour, postpartum activity and reactivity in sows. Effects of farrowing environment, previous experience and temperament. Applied Animal Behaviour Science 77: 53-76

Thodberg, K., Jensen, K.H. and Herskin, M.S. (2002b) Nest building and farrowing in sows: relation to the reaction pattern during stress, farrowing environment and experience. Applied Animal Behaviour Science 77: 21-42

Weschler, B. And Weber, R. (2007) Loose farrowing systems: challenges and solutions. Animal Welfare. 16: 295-307

Weber, R., Keil, N.M., Fehr, M. And Horat, R (2007) Piglet mortality on farms using farrowing systems with or without crates. Animal Welfare 16: 277-279

Weber, R., Keil, N.M., Fehr, M. And Horat R. (2009) factors affecting piglet mortality in loose farrowing systems on commercial farms. Livestock Science 124: 216-222

Wischner, D., Kemper, N. And Krieter, J. (2009) Nest building behaviour in sows and consequences for pig husbandry. Livestock Science 124: 1-8

Zoric, M., Mattsson, S., Kjellerby, P. and Wallgren, P. (2008) Incidence of Lameness and Abrasions in Piglets in Identical Farrowing Pens with Four different types of Pens. Available at: https://actavetscand.biomedcentral.com/articles/10.1186/1751-0147-51-23 (Accessed 10 February 2009).