Applied Animal Behaviour Science 169 (2015) 9–16

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

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

Achieving optimum performance in a loose-housed farrowing system for sows: The effects of space and temperature

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ARTICLE INFO

Article history:
Received 30 November 2014
Received in revised form 10 May 2015
Accepted 17 May 2015
Available online 27 May 2015

Keywords:
Free farrowing
Space
Temperature
Piglet survival
Maternal behaviour

ABSTRACT

Piglet survival relies on interactive influences of the sow, her piglets and their environment. There are a number of design challenges in a loose-housed farrowing and lactation system to optimise this dynamic, including achieving farrowing in the desired location (i.e. a protected nest area) and minimising crushings. The PigSAFE (Piglet and Sow Alternative Farrowing Environment) pen was developed with these challenges in mind. It has different areas to fulfil different biological and managerial needs, including a solid-floored nest area with piglet protection features (sloped walls, heated creep) intended for farrowing. Two hypotheses regarding pen design features to optimise farrowing location and improve piglet survival were tested: (i) greater space would improve maternal behaviour; and (ii) a heated nest-site would be more attractive to the farrowing sow. PigSAFE was adapted to give a LARGE treatment, 9.7 m^2 in total with a nest area of 4.0 m^2, and a SMALL treatment, same design but 7.9 m^2 in total with a nest area of 3.3 m^2. The nest floor was heated to either 30 °C (T30) or 20 °C (T20) from 48 h before until 24 h after farrowing. A 2 × 2 factorial design saw 88 Large White × Landrace sows randomly assigned to space and temperature treatments. Generalised linear mixed models were used to analyse performance data. Farrowing location analysis involved dividing the pen into seven areas (L1–L7); L1 deemed the safest location for the piglets to be born (in the nest, furthest from dunging area, closest to creep) and L7 the least protected (in the dunging area). Of all the piglets born 97% were born in the nest area. The majority of sows started farrowing in L1 (56%), with 39% of remaining piglets being born in this location. There was a significant Space × Temperature interaction for farrowing location (P = 0.011) with SMALL_T20 achieving the most L1 births. Temperature had no significant influence on piglet survival (Total mortality P = 0.401; Live-born mortality P = 0.826). However space influenced mortality, with significantly greater live-born mortality when sows were afforded a larger farrowing space (LARGE = 18.1% vs. SMALL = 10.9% P = 0.028). There were no significant interactions between space and temperature for either total mortality (P = 0.394) or live-born mortality (P = 0.685). The overall design successfully promoted farrowing in the nest location, irrespective of nest size and floor temperature. The higher piglet mortality in the LARGE treatment suggests that the larger nest size was less protective for the piglets and thus a smaller nest, within an adequate total pen size for differentiation of functional areas, would be recommended.

1. Introduction

Confinement of the sow during farrowing and lactation is a welfare issue which is a continuing focus for public concern and debate. At the present time, the majority of sows farrow in conventional farrowing crates (approximately 60% of sows farrow indoors in the UK with 96% of these in crates – Guy et al., 2012; 95% in EU and 83% in USA – EFSA, 2007; NAHMS, 2000), many with partly or fully slatted flooring for manure management as slurry. This places limitations on the freedom of movement of the sow and some practical constraints on the types of substrate which can be used to allow expression of nest building behaviour. There has been significant research into developing alternatives to the farrowing crate (for reviews see Baxter et al., 2012; Edwards and Fraser, 1997) but as yet there is no large-scale commercial up-take of a non-crate indoor farrowing system other than in countries where the crate has been prohibited (Sweden, Switzerland and Norway). Constraints preventing voluntary uptake in countries where farrowing crates are

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http://dx.doi.org/10.1016/j.applanim.2015.05.004
0168-1591/

permitted include valid farmer concerns about the ability for a loose-housed system to deliver high piglet survival rates, acceptable capital, running and labour costs, efficient labour routines and operator safety (Baxter et al., 2012). There is consequently a need for new alternatives to the farrowing crate that provide maximal sow and piglet welfare whilst addressing these concerns.

The PigSAFE (Piglet and Sow Alternative Farrowing Environment) project aimed to tackle this challenge and developed pen design criteria (based on those summarised in a review by Baxter et al., 2011a) that should provide the correct stimuli required to achieve the desirable outcomes. Since sows show clear preferences for a feeding area separate to both the dunging and nesting areas (Andersen and Pedersen, 2011), the pen incorporates different functional areas: a nest-site with a separate heated corner creep for the piglets, a dunging area and a lockable feeding stall. The nest-site provides enclosure on three sides, an entrance providing a view into the adjacent pen and a solid floor so that substrate can be provided for nest-building. These criteria were based on sow preference experiments demonstrating the importance of such features (e.g. Cronin et al., 1998; Hunt and Petchey, 1987). Under-floor heating was also installed in the nest-site to offer the possibility of additional thermal support for the newborn piglets and provide a greater temperature differential from the dunging area which might attract sows into the nest for farrowing (Phillips et al., 2000; Pedersen et al., 2007). The dunging area was separate and fully slatted to satisfy the sow's preference to dung away from the nest-site (Wiepkema, 1986; Damm and Pedersen, 2000) as well as fulfilling hygiene criteria for the stockworker.

The objective of this experiment was to investigate the sows' use of the designated functional areas in this new pen design, and to address two questions regarding design criteria – namely how much space does the sow require to achieve good performance and whether thermal enhancement of the nest area encourages correct farrowing location and improves piglet survival. It was hypothesised that (i) more space would result in better separation of functional areas and facilitate nest-building behaviour which, since feed-back from the unconstrained performance of nest-building behaviour can affect neuro-endocrine regulation of maternal behaviour (Castrén et al., 1993; Damm et al., 2003; Pedersen et al., 2003; Algers and Uvnäs-Moberg, 2007), would improve subsequent maternal behaviour and piglet survival (Arey et al., 1991; Jensen, 1993; Damm et al., 2003; Pedersen et al., 2003; Yun et al., 2013); and (ii) that a warmer nest floor would be more attractive to farrowing sows and reduce piglet mortality predisposed by perinatal hypothermia (Pedersen et al., 2007).

2. Materials and methods

2.1. Ethical statement

This study was reviewed and approved by the SRUC Ethical Review Committee (approval ID: ED AE 5/2009). All animal management procedures were adhered to by trained staff.

2.2. Animals and housing

Eighty-eight Landrace × Large White (Pig Improvement Company, Kingston, Oxfordshire, UK) sows and gilts (hereafter sows; average parity 2.42 (±sem 0.15)) were randomly selected to take part in this experiment. All animals were housed at the research farm of Scotland's Rural College (SRUC) in Midlothian, Scotland. During gestation sows were housed in groups no larger than six per pen. The pens were 3.60 m × 6.25 m, consisting of an enclosed straw-bedded area at the rear (3.60 m × 2.50 m), a central dunging passage (3.60 m × 1.95 m), and an access passageway plus six individual feeding stalls side by side at the front (each 0.5 m wide, 1.8 m long). Sows were fed a standard pregnancy diet, once a day (2 kg containing 12.74% CP, 13.32 MJ DE kg^{-1}). After farrowing, lactation diet (17% CP, 13.75 MJ DE kg^{-1}) was offered at a rate of 3 kg per day followed by 0.5 kg increments each day until 7 kg and then followed by 1 kg increments each day up to a maximum of 12 kg until weaning. Throughout, all animals had ad libitum access to water. Approximately 5 days before their expected due date, sows were weighed, condition scored and had their backfat thickness measured at the P2 position before being moved into farrowing accommodation (PigSAFE pens). Average pre-farrowing weight, condition score (0–5 scale) and P2 measurements for sows were 258.1 ± 3.53 kg, 3.30 ± 0.07 score and 20.91 ± 0.39 mm respectively.

PigSAFE (Piglet and Sow Alternative Farrowing Environment) pens had a basic nest area, with solid and insulated concrete flooring to allow provision of nesting material. For nesting, 2 kg of long-stemmed straw was maintained by daily replenishment (not cumulative) from day −5. This level was maintained until day +7 and then it was reduced to 1 kg of straw daily until weaning. The nest was equipped with sloping walls against which the sow can slide more slowly to ground level for suckling, which had a gap between their base and the floor to lower the risk of piglets being trapped and killed. A heated, corner creep area (0.75 m^2) with easy access from the nest was bedded with a thin layer of sawdust. The solid nest area was equipped with under-floor heating which could be adjusted on a pen by pen basis (see Section 2.3). A separate slatted dunging area (Triband metal 9 mm void) was bounded by walls with barred panels to adjacent pens to discourage farrowing outside the nest and allow visual and oral–nasal contact between neighbouring sows. A feeding stall for the sow (0.50 m wide, bounded by solid sides) was included at one side of the pen, where the sow could be locked in to allow safe inspection or treatment of the piglets. This basic prototype pen design was adapted to determine the influence of space and temperature on farrowing location, maternal behaviour and piglet survival (Fig. 1a and b).

2.3. Experimental design

The sows were randomly assigned to treatment groups in a 2 × 2 factorial design to test the influence of space and nest floor temperature on farrowing location and maternal behaviour. The sows were either assigned to the LARGE space treatment (9.7 m^2 in total; dunging passage = 2.20 m × 1.60 m, nest-site = 1.30 m × 2.80 m) or the SMALL space treatment (7.9 m^2 in total; dunging passage = 2.20 m × 1.23 m, nest-site = 0.90 m × 2.38 m). The nest-site floor was heated to either 20 °C (T20) or 30 °C (T30) from 48 h before until 24 h after farrowing. Fig. 1 illustrates the experimental pens side-by-side. The overall farrowing room temperature was set at 18 °C for the first week during and after farrowing, before being reduced to approximately 16 °C for the remainder of lactation. Creep temperatures were set at 30 °C for farrowing and the first week post-farrowing before being set on a curve gradually reducing the temperature to approximately 25 °C for the remainder of lactation.

2.4. Data collection

Piglet mortality was recorded with post-mortem examination confirming cause of death. Video cameras (Low-lux B/W waterproof cameras: SK-2020XC/SO, RF Concepts Ltd, Belfast, Ireland) captured continuous data from all pens from day −5 until at least day +2 post farrowing. Farrowing kinetics (cumulative farrowing duration and average birth interval) were recorded. Of particular interest in this study was where in the pen sows chose to farrow and the quality of maternal behaviour in terms of posture changes during