



Evidence Project Final Report

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- This form is in Word format and the boxes may be expanded, as appropriate.

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Project identification

1. Defra Project code

2. Project title

3. Contractor organisation(s)

4. Total Defra project costs (agreed fixed price)

5. Project: start date.....

end date.....

6. It is Defra's intention to publish this form.

Please confirm your agreement to do so.YES NO

(a) When preparing Evidence Project Final Reports contractors should bear in mind that Defra intends that they be made public. They should be written in a clear and concise manner and represent a full account of the research project which someone not closely associated with the project can follow.

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(b) If you have answered NO, please explain why the Final report should not be released into public domain

Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

Background:

Defra and others have funded research to find suitable alternatives to the farrowing crate but, there is as yet no significant acceptance of such systems at the commercial level. Inconsistent delivery of acceptable production figures when moving from experimental to commercial evaluation is often cited as the reason for limited uptake of alternative systems. This highlights how successful adoption not only depends on optimum system design to satisfy the needs of the sows, piglets and stockperson, but also on appropriate management on a day-to-day basis. Tackling the system design challenge was the main remit of the initial Defra-funded project (AW0143 Phase I – 2008-2011, final report submitted separately in 2011), which aimed to re-design the farrowing environment to optimise both animal welfare and economic performance. This “PigSAFE” project (Piglet and Sow Alternative Farrowing Environment) developed a welfare-friendly and efficient system which demonstrated promising performance figures when tested against conventional farrowing crates. In addition, the project generated considerable producer interest as a potential alternative to the conventional farrowing crate. Engagement with industry was prioritised throughout and repeated requests for information were fulfilled by producer-relevant publications, numerous producer talks and hosting of site visits. This has resulted in several building projects on commercial farms and proposals for further adoption. Continuing this momentum within the industry is an important part of achieving successful roll-out of confinement-free farrowing and lactation systems and such a process requires support. By monitoring performance we can determine whether results shown at the experimental level are replicated commercially, identify potential areas of weakness and opportunities to improve aspects of a system where necessary.

Objectives:

The overall aims were to coordinate the monitoring of alternative systems and the exchange of information between researchers and industry, analyse key components in design and management which affect commercial success, produce updated guidance notes and develop standard operating procedures for loose-housed indoor farrowing and lactation management. There were three main objectives:

1. Provide technical and economic expertise for potential adopters
2. Monitor and analyse performance of systems
3. Develop standard operating procedures and protocols for management of loose-housed indoor farrowing and lactation systems

Results and Discussion:**Objective 1:**

Expertise was provided to early adopters and other interested parties in several formats, including face-to-face consultancy and site visits, documents about the PigSAFE project, design and management of the pen. In addition a web-based resource was developed (www.freefarrowing.org).

Industry-relevant documents were produced in response to continuing requests for information about the project, including performance results, economic evaluation and details about how to build pens. These included i) The PigSAFE project - final project report summary 2012, ii) PigSAFE recommended design and building tips_ 2012 and iii) PigSAFE recommendations for husbandry procedures.

As interest within the industry to adopt alternative farrowing systems grew, it became clear that there was a great deal of mis-information and mis-representation of research on the welfare detriments and advantages of certain systems, and thus a genuine need to provide robust, evidence-based information in a clear format. The website was developed primarily in response to this. There is a great deal of activity, both in the UK and Europe, in developing alternative farrowing systems, therefore information on different systems is becoming available all the time. The website is therefore not PigSAFE specific; it is a non-profit site that acts as a portal for information (both scientific and industry relevant) on the various issues surrounding farrowing and lactation environments, information on existing designs that are available (both those that have undergone formal research such as PigSAFE and those that are available

commercially without an official evidence base), farmer resources (e.g. husbandry advice, economic information) and information on welfare legislation and the various requirements from different assurance schemes.

Economic expertise: During the original PigSAFE project a spreadsheet model was constructed that estimates the costs of producing pigs in different loose-housed farrowing and conventional farrowing systems. The model estimates the cost of production for the dry and farrowing sow phases, and the subsequent post-weaning phase to produce a weaner pig up to 35kg. Using updated farm-scale costings from producers and building designers it was demonstrated that the costs of production using a PigSAFE system would be 8% higher compared to using a standard farrowing crate if performance levels are on a par with standard systems. The additional costs are primarily a result of the additional space required for a PigSAFE pen. Cost neutral scenarios include receiving a price premium of 3p/kg dead weight, which would be reduced if the system achieved better sow performance or better weaning weights (a result that has been demonstrated as a possibility in Phase I). Whilst these figures potentially limit uptake of this system, it is important to understand that the build costs are likely inflated as the system is not available “off the shelf”. There is current commercial development of a modular pen design, and associated interest in creating a containerised version of the system which will be cheaper, available as a standard package purchase, and therefore more attractive to potential adopters.

Objective 2:

Twenty-three commercially relevant sites (11 in the UK, 12 abroad – not including Sweden, Switzerland and Norway where farrowing crates are banned) were identified as having operational indoor loose farrowing and lactation systems, and/or planning approval to build. This figure is likely to be an underestimate of the actual number of operational sites, especially when including sites that have installed temporary crating systems. Performance data have only been made available from five commercial sites; three sites have actual PigSAFE pen designs and the remaining two have different systems. Comparative data with farrowing crates on the same farms have been difficult to obtain, with one farm only operating loose farrowing. On UK farms where PigSAFE pens have been installed, live-born piglet mortality averages 12.7%, with 10.1 weaned from 11.2 born alive. On farms where non-PigSAFE loose systems are installed live-born piglet mortality averages 16.7%, with 11.2 weaned from 14.2 born alive.

One objective was to identify problem areas and troubleshoot possible solutions to performance issues. Of the measurable variables, the key factors that influence performance are:

- Litter size – higher litter size correlates with higher mortality
- Parity – sows of parity 5+ show higher mortality
- Farm – there are significant differences between farms in performance (farm will include influences of staff, pen-type and genotype)
- Pen design – where changes have been made to recommended pen designs there has been a significant (negative) influence on performance

Objective 3:

Confinement systems have had a long history of trial and error to develop refinements and to optimise working routines. Alternative systems require the same process. It is clear from the data collected for objective 2 that there is variability between farms and between batches within farm. Part of this variability will be a result of management. Objective 3 aimed to optimise working routines for management of sows in loose farrowing. This process is continually developing as early adopters share information about their experiences. We have published current best practice standard operating procedures on the website at:

www.freefarrowing.org/info/4/farmer_resources/5/free_farrowing_husbandry.

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
- ☐ the objectives as set out in the contract;
 - ☐ the extent to which the objectives set out in the contract have been met;
 - ☐ details of methods used and the results obtained, including statistical analysis (if appropriate);
 - ☐ a discussion of the results and their reliability;
 - ☐ the main implications of the findings;
 - ☐ possible future work; and
 - ☐ any action resulting from the research (e.g. IP, Knowledge Exchange).

Project report to Defra

The following details the final report for Phase II of the AW0143 project. Phase I was completed in 2011 and a final report was submitted separately on completion in December 2011.

Objectives:

1. Provide technical and economic expertise for potential adopters of free farrowing
2. Monitor and analyse performance of systems
3. Develop standard operating procedures and protocols for management of loose-housed indoor farrowing and lactation systems

Summary of methods, results and conclusions for each objective

Objective 1: This objective had three scientific milestones.

- i) Provide written reports predominantly for industry use that highlight the main results from the PigSAFE project:

These documents were produced in response to continuing requests for information about the project, including performance results, economic evaluation and details about how to build pens.

- The PigSAFE project - final project report summary 2012
- PigSAFE recommended design and building tips_ 2012
- PigSAFE recommendations for husbandry procedures

Requests were predominantly from producers, therefore these documents were written with this target audience in mind and provide practical and detailed advice as well as summarising the main scientific findings of the experimental study. They were approved for distribution by Defra in November 2012 and over 45 requests have been made directly to the project team, resulting in follow up consultation with three adopters and at least three potential builders. Further information on requests is provided at the end of this section where details of knowledge transfer activities are given. BPEX also have copies of the documents and are able to disseminate to a greater number of interested parties. Documents have also been posted on the website (see milestone ii).

The final document recommending husbandry procedures is based on our practical experience specifically with the PigSAFE pens. As part of Objective 3 a more generalised protocol for free farrowing sows and litters has been developed.

In addition to these documents economic expertise has been provided to interested parties. During the original PigSAFE project a spreadsheet model was constructed that estimates the costs of producing pigs in different loose-housed farrowing and conventional farrowing systems. The model estimates the cost of production for the dry and farrowing sow phases, and the subsequent post-weaning phase to produce a weaner pig up to 35kg. Using updated farm-scale costings from producers and building designers it was demonstrated that the costs of production using a PigSAFE system would currently be 8% higher compared to using a standard farrowing crate. Data have also been provided for a temporary crating option which is a system available commercially (Table 1).

Table 1. Current commercial farm scale quotations for three different farrowing and lactation systems.

	Farrowing Crate	PigSAFE	360° Farrower (temporary crating system)
Area (m ²)	4.3	8.9	4.3
Floor/bed	Fully slatted	Part slatted/straw	Fully slatted
Capital £ per place	2,900	5,671	3,437
Differential		+95%	+19%
Production cost/weaned pig (same performance – 8% mortality)	29.72	32.13	30.82
Differential		+8%	+4

The cost assumes performance levels are on a par with standard systems, which has been set at live-born mortality of 8%. This figure is achieved by commercial producers involved in the project as well as our research farms. We have no reliable large-scale data on the levels being achieved by temporary crating systems. The additional costs for PigSAFE are primarily a result of the additional space required for the pen. Cost neutral scenarios include receiving a price premium of 3p/kg dead weight (Table 2), which would be reduced if achieving better sow performance or better weaning weights (a result that has been demonstrated to be a possibility in Phase I).

Table 2. Costs of finished pig production £/kg carcass for pigs produced in a standard farrowing crate and a PigSAFE system

Scenario	Yard-Crate	Yard-PigSAFE	Estimated premium required	
			£	% of retail price
Carcass price premium for break even	1.42	1.45	0.03	0.4
Fewer piglets weaned in PigSAFE (-0.5 per litter)	1.42	1.50	0.08	1.3
Heavier piglets weaned in PigSAFE (+0.3 kg per piglet)	1.42	1.44	0.02	0.2

Whilst these figures potentially limit uptake of this system it is important to understand that the build costs are likely to be inflated as the system is not available “off the shelf”. There is current commercial development of a modular pen design, and associated interest in creating a containerised version of the system which will be cheaper, available as a standard package purchase, and therefore more attractive to potential adopters. Quotations for this option are currently being sourced and, when made available by the suppliers, an economic analysis will be added to the website (see milestone ii below) as a further case study.

ii) Develop a website offering relevant information from the PigSAFE project as well as a member’s only area for producers to upload performance information and benchmark their system.

A website has been created - www.freefarrowing.org and went live in August 2014 (see Figure 1).

The original PigSAFE project not only designed an alternative farrowing and lactation environment but also reviewed all of the literature on this subject and provided peer-reviewed publications on design criteria required to meet the animals' biological needs and the welfare and economic aspects of existing systems. As interest within the industry to adopt alternative farrowing systems grew, it became clear that there was (and still is) a great deal of misinformation and mis-representation of research on the welfare detriments and advantages of certain systems, and thus a genuine need to provide robust, evidence-based information in a clear format. Thus, in addition to providing all of the detailed information on the PigSAFE design and how to build it, the published work from the first phase of the PigSAFE project was translated into a format suitable for a web resource and suitable for our main end-user (i.e. producers).

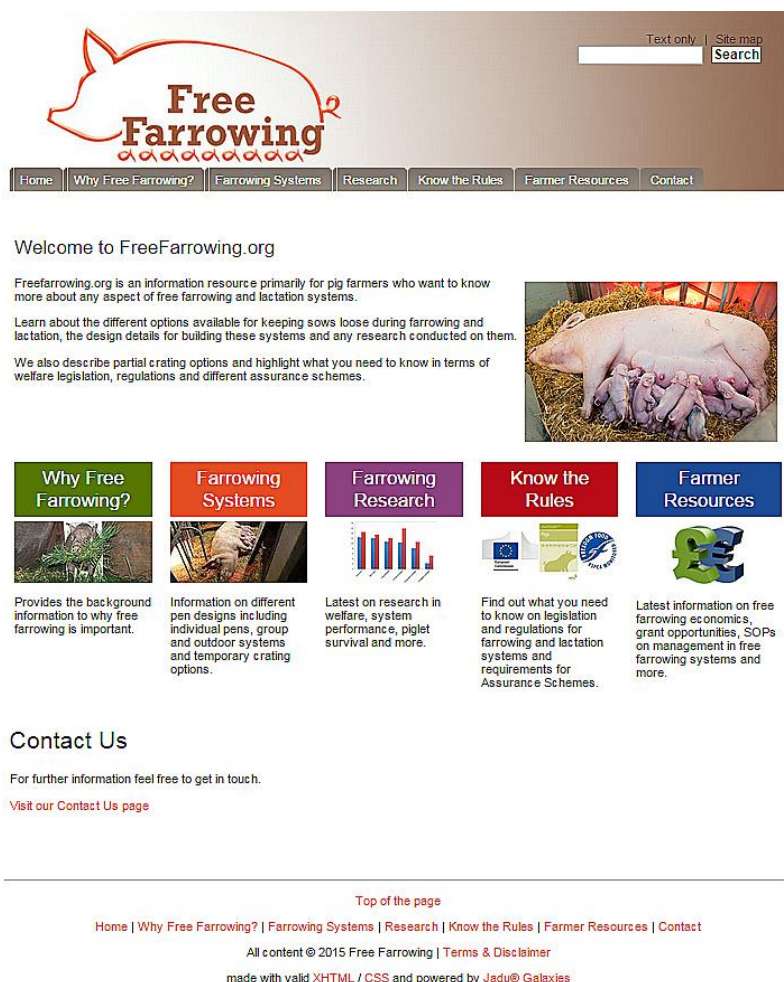


Figure 1. Screen capture of homepage of www.freefarrowing.org

There are five main sections within the website; the aims, their basic content and information about where data have been sourced are described briefly below:

- **Why Free Farrowing?**

Aims to provide background information on the farrowing crate, the welfare detriments associated with it and the importance of providing systems that meet the biological needs of the animals involved whilst still safe-guarding the interests of the stock-person. Information sourced and translated for a web-user from Baxter et al. 2011, 2012 reviews of farrowing and lactation systems (in *Animal* 5:4, 580-600 and *Animal* 6:1, 96-117) .

- **Farrowing Systems**

Information on existing systems is provided in a standard format. Systems are categorised as: Individual Pens, Temporary Crating, Group, Outdoor, Kennel and Run. Where available there are design specifications for building the systems and links to researchers and companies that can provide more information. Where information was not publically available, the creators of these systems were contacted to agree to share information in a standard format on the website. An additional section was created to give information on Specific Pen Features. This section was

created as a result of our research demonstrating that design details are critical to system success. We wanted to including specifics on “furniture” within pens such as support structures to protect piglets and assist posture changes, as well as advice on creep design and flooring material.

- Farrowing Research

Results from PigSAFE as well as previous work including research funded by Defra on sow welfare have been translated for the target audience. There is also initial agreement from international colleagues to share information of other systems being researched as the data become available.

- Know the rules

Welfare regulations and legislation at National and EU level; assurance scheme requirements (e.g. Freedom Foods (now RSPCA Assured), Soil Association etc...); which supermarkets provide pork from free farrowing sources and labelling information. This information was translated for the website with the assistance and approval of government (welfare legislation) and NGOs (assurance schemes).

- Farmer resources

These pages include information on costings and management. Costings information has been calculated by Newcastle’s farm economists working on the project, using data provided by producers and pig building companies. Husbandry recommendations have been developed in collaboration with stock-people (UK, Denmark and Australia) experienced with management of sows and litters in free farrowing accommodation.

This centralisation of all of the relevant information will hopefully facilitate responsible adoption of alternative systems to the farrowing crate. Details on website “traffic” so far are provided in the section detailing knowledge exchange activities.

As part of this objective there was an intended milestone to develop an on-line database of information on performance of alternative farrowing systems. Though a database has been compiled of performance information it will not be in an on-line format (see Objective 2). Many early adopters are building alternatives with the expectation of fulfilling requirements of assurance schemes which would facilitate a niche price and/or with the support of supermarkets. As a result, sharing data is sensitive and, whilst adopters are willing to allow us to monitor performance as researchers, anonymity is requested and an on-line database where producers may want to benchmark performance is unlikely to be utilised at present. In addition, whilst the website can function very effectively as a portal for information on farrowing and lactation systems, a more powerful and sophisticated host site would be required to support a database function. If producers decide they require this function in the future BPEX will be approached for assistance via their website which supports KPI benchmarking.

iii) Identify existing loose farrowing and lactation systems in operation and those producers interested in building loose farrowing systems.

The project plan was presented to BPEX’s R&D and KT department in January 2013, in order to help identify producers in the UK with loose farrowing and lactating systems or those who might be interested in building. This interaction as well as talks given at producer meetings resulted in successful contact with a number of producers building specific PigSAFE pens, as well as producers trialling other alternatives. International researchers also working in this area were contacted to identify other potential sources of information. Denmark continues to make significant progress in this area and there are a number of large scale units operating completely loose-housed systems. Denmark’s intention is to achieve 10% of their herd loose farrowing by 2020, the equivalent to approximately 125,000 sow places (NB: calculation based on DK sow breeding herd numbers published Dec 2014).

At the time of this report there were 23 commercially relevant sites identified as having operational alternative farrowing and lactation systems, and/or planning approval to build (11 in the UK, 12 abroad – not including Sweden, Switzerland and Norway where farrowing crates are banned). The number of sow places varies greatly between sites and this figure is likely to be an under-estimate of the actual number of operational sites. Some data provided by sow places per country rather than individual sites (e.g. DK).

A summary is provided in the supplementary material. It provides the current information regarding existing loose systems both in the UK and abroad. Where the information is available, pens are categorised into pen type – such as

simple pens, designed pens (e.g. PigSAFE), etc. This summary includes existing as well as planned systems. At this stage the summary does not include outdoor systems, however we have decided to include farms which employ temporary crating as this is an increasingly popular alternative to conventional, full lactation crating.

Milestones iv) and v) were reporting milestones and they were fulfilled.

Conclusions: Interest in loose farrowing and lactation systems has gathered momentum over the course of the project. This has resulted in significant numbers of alternative systems being built commercially both in the UK and abroad. There are a range of systems available, some of which have undergone formal research. The capital investment required to install a designed pen system which has undergone formal research, such as PigSAFE, is significant and could prevent further uptake despite promising performance results commercially. However providing an “off-the-shelf” option will be cheaper and more attractive to producers interested in free farrowing, and there are current developments in this direction. Information on system design, free farrowing research, welfare legislation, assurance scheme requirements, free farrowing husbandry and other farmer resources was synthesised for publication on a web-based platform, www.freefarrowing.org, to act as a portal primarily for industry use.

Objective 2: This objective had three scientific milestones.

vi) Develop a database for performance information

Raw performance data can be misleading. Piglet mortality is a multifactorial problem and data related to mortality should be considered using a multivariate statistical approach to correct for factors that may influence performance and allow accurate monitoring of performance. One of the main objectives of the project was to populate a database with production information to allow accurate analysis of system performance. This would determine whether results obtained during the experimental phase could be replicated at the commercial level. There are sensitivities with sharing data from a number of the sites and it has been difficult to acquire commercial data. However data have been made available from five commercial sites and a database has been created for analysis (see milestone viii)).

vii) Create an on-line database

As previously described in Objective 1, milestone ii) an online database was not created as data are commercially sensitive and such a resource is premature at this stage in the uptake of these alternative systems.

viii) Monitor performance and identify potential problem areas

Verbal reports of overall performance have been common throughout the project. Live-born mortality has been reported to range between 8-26%, highlighting inconsistencies in performance across sites. Determining the risk factors associated with inconsistent performance involved analyses of raw data which have been difficult to obtain in the detail required to accurately assess performance. Where raw data were made available (three farms, over 1000 litters), we have been able to determine which factors affect performance and therefore identify potential problem areas. Data were analysed using Generalised Linear Mixed Models with the key performance indicator (i.e. percentage total mortality, live-born mortality, number weaned, etc...) fitted as the response variable. Parity, litter size, farm and pen type were fitted as fixed effects, with batch fitted as a random factor.

Litter size and parity were significant risk factors for mortality, particularly for stillborn mortality ($F_{1,966}=23.36$ $P<0.001$, $F_{4,900}=13.00$ $P<0.001$, respectively; Figure 2a and b give more details). As litter size increases so do the percentage of stillbirths. Sows of parity 5 and above have a higher number of stillbirths.

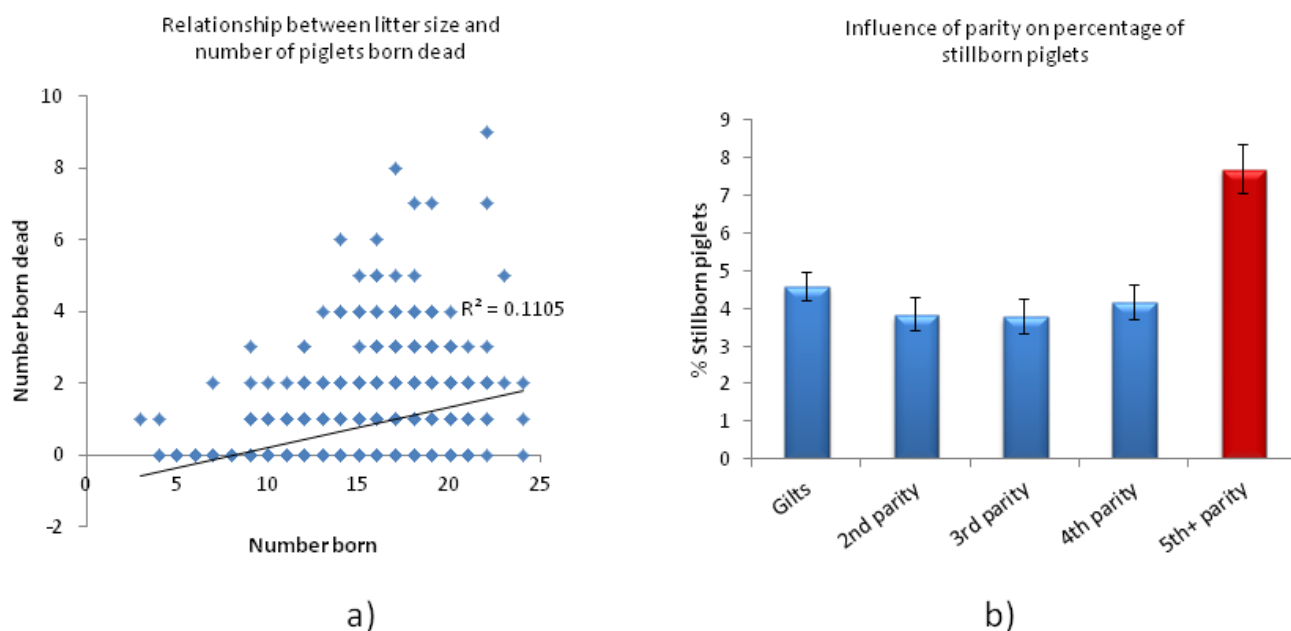


Figure 2: a) Relationship between litter size and number born dead and b) influence of parity on percentage of stillborn piglets. Data provided by commercial farms farrowing in a range of loose farrowing accommodation.

Even with both these factors fitted into the model, farm significantly influenced piglet mortality ($F_{4,960}=16.2$, $P<0.001$). The average results per farm are presented anonymously in the supplementary material (Appendix 1).

Where extra information was available, analysis could be conducted within farm to identify areas of potential weakness. One farm (Farm A) trialed a small number of PigSAFE pens on their unit in order to “get used” to free farrowing. These pens were built to the original PigSAFE design and in consultation with the AW0143 project team. Performance from initial trials of four pens with 10 batches (average parity = 3) demonstrated inconsistencies, which the farm staff determined as being related to provision of the correct quantity of straw in the system. They trialed different quantities of straw in their pens which they described as LOW, MEDIUM and HIGH. Analysis of their data revealed straw quantity had a significant effect on performance (summarised in Table 3) with LOW levels significantly reducing performance. The farm staff had realised straw was having a major effect on performance and for subsequent farrowing batches straw quantity was optimised for their system.

Table 3. Influence of straw quantity on performance in PigSAFE pens trialed commercially.

	LOW	MEDIUM	HIGH	F-statistic	P-value
% Total mortality	26.3	14.6	12.5	3.50	0.030
% Live-born mortality	19.8	4.5	9.0	6.27	0.002
% Stillborn	8.5	10.7	4.6	2.24	0.106

Once straw quantity was optimised and staff were more comfortable with the system, Farm A wanted to build four more pens, however the farm staff decided they did not need/want the feeding stall and therefore subsequent pens were built without this feature. Analysis of Farm A’s data reveals promising results (Total mortality % = 16.4 ± 1.5 ; Live-born mortality % = 12.7 ± 1.4 ; Stillborn % = 3.6 ± 0.6) with approximately 11 piglets weaned at an average weaning weight of 8.6kg per piglet. Whilst these results are promising, Farm A reported that although their farrowing crates wean lighter piglets, they are managing 4% less mortality. To assist this farm with augmenting performance, their data were scrutinised further.

One important comparison was to determine whether there were any differences between performance in the original PigSAFE design and the adaptation without the feeder. Figure 3 demonstrates a significant difference between the two designs, with the adapted design showing higher piglet mortality. When auditing the system we found that, although the footprint of both systems was the same, the nest dimensions in the adapted and less

successful design had been altered, making it wider. Such a result echoes results found during prototype development in the first phase of the project. The project tested the effects of space on farrowing location and performance and compared a “large” pen (9.7m² in total (2.2m x 4.4m), with a nest area of approximately 4.0m²) to a “small” pen of the same design (7.9m² in total (2.2m x 3.6m) with a nest area of approximately 3.3m²). The large pen returned significantly poorer performance which was likely a result of the larger nest size. A larger nest size can result in less supported posture changes (i.e. more rolling behaviours from ventral to lateral which can result in piglets being trapped) and there is greater space for piglets to move away from the heated creep area and the sow’s udder which can increase the risk of hypothermia and starvation.

Performance differences between original and adapted PigSAFE design

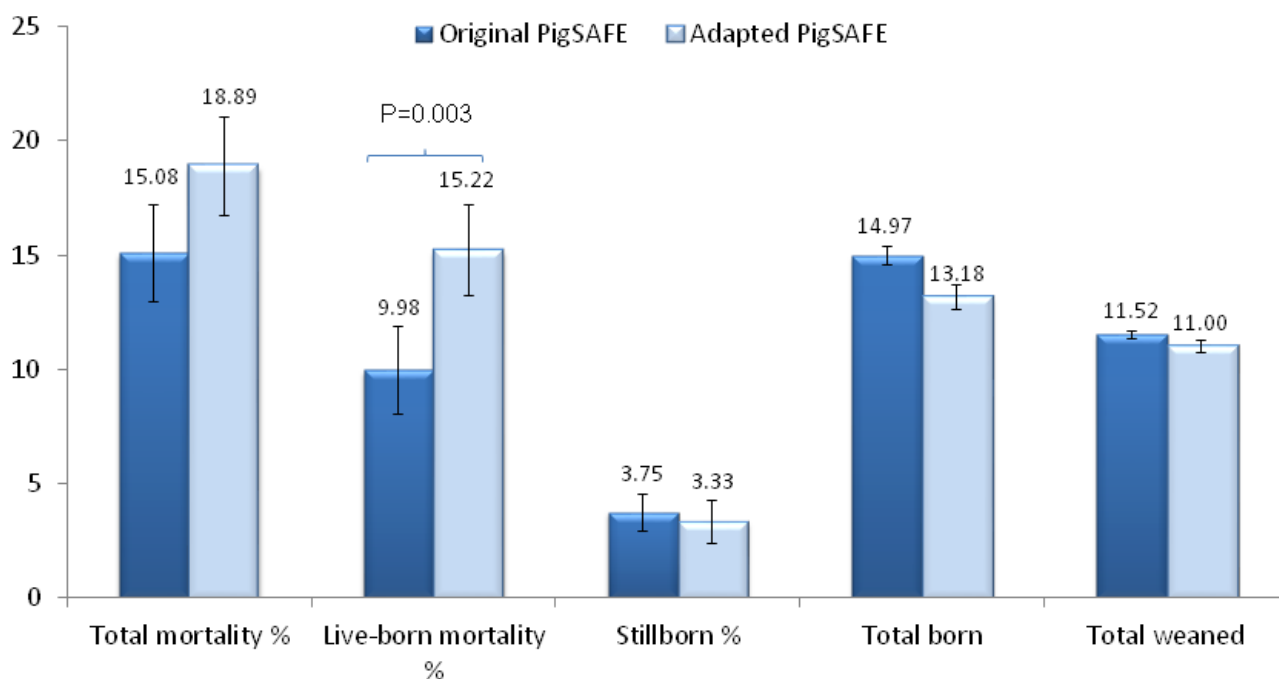


Figure 3. Influence of pen alterations on performance (commercial Farm A)

Whilst these results are important in emphasising the main message from the project that design details are critical to success, there may be other factors that are influencing performance. With such a small number of pens outliers can have more of an affect on the data. Optimising pen design is paramount to achieving good performance, however inconsistencies as a result of individual variation in maternal behaviour involves a more long-term strategy to select the right sows for indoor loose farrowing systems (see current and future research activities).

The major cause of piglet mortality in farrowing systems where the sow is kept loose is crushing by the sow. From cause of death data made available by three commercial sites, crushing accounted for 60% of all deaths, with stillbirths at 24%, low viability deaths at 10%, starved only 2% and the remaining 4% attributed to other causes such as birth defects. Given that crushing is the major cause of death, it is prudent to determine what percentage of sows in the population actually crush piglets. From a dataset of over 900 sows, it was shown that the majority of them (51%) could be termed “non-crushers” (i.e. crushing zero or one piglet according to Andersen et al. 2005 – Applied Animal Behaviour Science 93; 229-243). Certain individual sows were responsible for multiple crushes. The positive aspect is that the majority of sows can perform well in free farrowing systems and, if they could be identified as appropriate to farrow in these systems, this would increase consistency in performance and therefore producer confidence and further uptake. There were farm differences with percentages of “non-crushing” sows ranging from 40% to 66%, suggesting the occurrence of genotype by environment interactions. This is understandable with different farms having different systems, genotypes and staff. If the pen and people elements can be optimised then any genetic selection strategies would be more effective.

Milestones ix) and x) were reporting milestones and they were fulfilled.

Conclusions: Monitoring commercial performance has demonstrated that results observed at the experimental level

can be replicated in industry. Full datasets are difficult to obtain, but where they have been made available the data demonstrate that litter size and parity significantly influence performance. Managing large litters in free farrowing systems will be a significant challenge that warrants investigation to determine best practice approaches. There are differences in performance both between farms and within farm where system designs are different. Design details are critical to success. Adapting designs that have undergone rigorous testing experimentally can influence performance. Consistency of performance remains a concern. Where datasets are small, outliers can skew the results. However the majority of sows can perform well in free farrowing systems. Identifying which traits make a good mother in these systems is an important aim in achieving consistent performance and therefore producer confidence in free farrowing. Optimal pen designs can be achieved. Optimising management is a challenge discussed in Objective 3.


Objective 3: This objective had one scientific milestone

xi) Develop standard operating procedures and protocols for management of loose-housed indoor farrowing and lactation systems

From the first phase of the project it was demonstrated that there was a period of adjustment for stock-people who were not used to working with loose animals and this was evident with performance improving as stock-people gained experience. Verbal reports from commercial sites suggest a similar situation is occurring in practice and the attitude with which a stock-person approaches the challenge of free farrowing management appears to influence the duration of the learning curve. It is clear that a different approach is needed when managing loose housed sows compared to those in crates.

Standard operating procedures have been developed based on our experience, the experience of commercial farmers operating loose farrowing and lactation systems and our expertise in animal behaviour and the human-animal relationship. We have collaborated with colleagues in Denmark who provided links to useful video footage demonstrating certain techniques. We have made this available for download on the website.

The recommendations include top tips on how to move animals into farrowing accommodation to minimise stress and how best to perform piglet management tasks in order to minimise disturbance to other litters and reduce maternal defensiveness, thus improve stockperson safety. Figure 4 shows a screen capture of the free farrowing husbandry SOP -> http://www.freefarrowing.org/info/4/farmer_resources/5/free_farrowing_husbandry



Free Farrowing Husbandry

Recommendations for managing animals in free farrowing systems

Farrowing house management can be challenging in any system. Not only are there general husbandry duties to perform such as feeding and mucking out, there are also situations where farmers may have to intervene to help piglets, treat sows and carry out other routine husbandry procedures. In order to achieve high levels of piglet survival good management is crucial. Interventions to promote piglet survival are needed more and more when litter sizes are higher than teat number.

When the sow is not confined in a crate the farmer must consider the best way to carry out these routine husbandry and piglet intervention tasks that achieve a safe and efficient working environment whilst respecting the maternal behaviour of the sow.

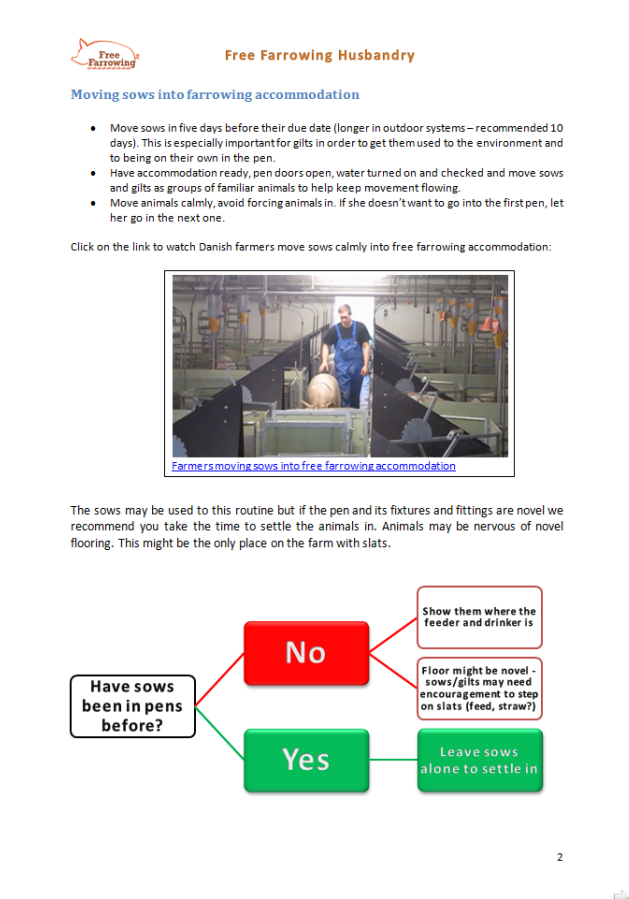
Some of these recommendations apply to any farrowing house; some are specific to free farrowing systems

Tasks to consider:

- Farrowing house preparation
- Moving sows in to farrowing accommodation
- Pre-farrowing sow management
- Nesting substrate management
- Mucking out
- Farrowing management
- Early post-farrowing management
 - Piglet processing
 - Piglet interventions - cross-fostering etc...
- Supplementary milk management
- Lactation management
- Creep feeding

Farrowing House Preparation

- Pens should be dry, having been washed and disinfected
- Flush slurry pits before sow entry (don't wait until they move in it causes disturbance).
- Set ambient and creep temperature controls (recommended 18-20°C for room. Heat lamps and/or mats set on a curve starting at 32°C - visit our Creep Recommendations page in [Farrowing Systems](#)).
- **Fix anything that needs fixing before the sows come in.** It sounds obvious but it is worth checking that all fixtures and fittings are working and anything that would require entry to the farrowing pen to fix is also working (e.g. lights above pens, fans and misters in hot climates).
- Suggest preparing creeps with a layer of sawdust/shavings and pens with a handful of straw for entry day.




Free Farrowing Husbandry

Moving sows into farrowing accommodation

- Move sows in five days before their due date (longer in outdoor systems - recommended 10 days). This is especially important for gilts in order to get them used to the environment and to being on their own in the pen.
- Have accommodation ready, pen doors open, water turned on and checked and move sows and gilts as groups of familiar animals to help keep movement flowing.
- Move animals calmly, avoid forcing animals in. If she doesn't want to go into the first pen, let her go in the next one.

Click on the link to watch Danish farmers move sows calmly into free farrowing accommodation:



Farmers moving sows into free farrowing accommodation

The sows may be used to this routine but if the pen and its fixtures and fittings are novel we recommend you take the time to settle the animals in. Animals may be nervous of novel flooring. This might be the only place on the farm with slats.

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    graph TD
      Q[Have sows been in pens before?] -- No --> A[Show them where the feeder and drinker is]
      Q -- No --> B[Floor might be novel - sows/gilts may need encouragement to step on slats (feed, straw?)]
      Q -- Yes --> C[Leave sows alone to settle in]
      
```

Figure 4. Screen capture of Free Farrowing Husbandry recommendations available at www.freefarrowing.org

In addition we are currently working with colleagues in Australia to develop SOPs specific to working with loose-housed animals in extreme climates (see current and future projects) where pen adaptations and additional management tools are required to minimise heat stress. This work is ongoing and we intend to develop the website further to provide information more relevant to specific countries.

In addition to system design and husbandry protocols, we have provided advice about the entire building process based on observations of systems in commercial practice and our own experiences. Advice does not relate to structural factors, such as optimum height and width of farrowing accommodation for ventilation, or to building regulations. The advice relates to factors that could influence human and animal behaviour. For example to reduce costs it would appear cheaper to have a large room of multiple pens rather than have fewer pens but multiple rooms. However too many pens per room could create a lot of disturbance for the sows. One badly behaved sow in a room could affect other sows around her, increasing crushing incidents and affecting staff morale. Multiple smaller rooms can allow staff to plan their working routine more efficiently and lower the risk of disturbance spreading. Whilst the first phase of the project found no influence of a quiet nest site on performance, the experiment was conducted in a building where there were only four pens per room, thus it could be argued that the situation was artificial compared to most commercial buildings. Understanding the potential contagion aspect of disturbance on maternal behaviour and staff perceptions of working environments would be useful research activities to further optimise free farrowing systems.

Milestones xii) and xiii) were reporting milestones and were fulfilled.

Conclusions: The stockperson is highly influential in the performance of free farrowing systems. Conventional crates

are fairly generic, have a long history of trial and error and have developed routines to enable efficient management. To a certain extent they also have the ability to limit the impact of poor stockpersonship and poor maternal behaviour. Free-farrowing and lactation systems are less forgiving of these aspects. When managing free farrowing systems stockperson safety, time management and consideration of the human-animal relationship are important aspects to consider. Understanding that free farrowing management is different to managing animals in crates is an important first step to developing best practice. Further work is needed to understand staff attitude towards free farrowing management and reasons for failure to adapt.

Main implications of the findings:

Free farrowing systems operating commercially can replicate promising performance demonstrated at the experimental level. Optimal pen design and the details of that design are critical to success. The PigSAFE pen has been shown to operate effectively commercially, however it is an expensive system and more work is needed to reduce its costs and determine whether health and welfare benefits demonstrated experimentally can translate into economic benefits. There is continued interest within the industry to explore opportunities to adopt free farrowing accommodation. However mis-information about the research, pen design and performance of free farrowing systems could be damaging. The website should continue to be a portal of accurate, impartial information for interested parties. Achieving consistent performance commercially is a concern for producers. Improving consistency requires optimising pen design, human inputs and animal inputs (i.e. genetic selection).

Current related projects:

Selecting the right sow for loose farrowing systems (FREESOW) – funders Sainsbury's.

<http://www.j-sainsbury.co.uk/responsibility/case-studies/2014/rd-grant-free-farrowing-to-increase-the-welfare-for-pig-farming/>

KBBE Prohealth Sustainable intensive pig and poultry production – funders EU.

<http://www.accelopment.com/en/projects/prohealth>

Innovative refinements of existing lactation pen systems to better suit Australian environmental and management - Funders - Australian Pork CRC

Possible future work to fill identified knowledge gaps:

- Identifying long-term animal health, welfare and economic benefits of free farrowing systems.
- Managing hyper-prolific sows and their litters in free farrowing systems.
- Understanding stockperson attitude to changes in management and failure of uptake.
- Optimise overall building shell design to minimise the contagion effect of disturbance.
- Optimising substrate provision and flooring to satisfy species-specific behaviours and hygiene.

Knowledge Exchange Activities:

The following outputs have been produced in the period since submission of the final report for Phase I of the AW0143 PigSAFE project in October 2011. Academic outputs can be found in section 9.

Presentations to industry and other stakeholders:

Baxter, EM. "Improving piglet survival – challenges and solutions in modern hyper-prolific sows". DSM "Bright Sows" meeting, Brecht, March 24th 2015. Meeting for vets and nutritionists.

Baxter, EM. "Designing farrowing systems and piglet survival". VIPiglet Advisory Board meeting, Herning, Denmark, March 12th-13th 2015. Meeting for Danish academics and organic producers.

Edwards, SA. "Risk factors for piglet mortality in free farrowing systems" VIPiglet Advisory Board meeting, Herning, Denmark, March 12th-13th 2015. Meeting for Danish academics and organic producers.

Baxter EM & Edwards SA. "The Farrowing Crate Dilemma: are we any closer to keeping piglets safe without them?" PVS Autumn meeting, Leeds, November 13th-14th 2014. Meeting for vets.

Baxter EM & Edwards, SA. "Recent developments in PigSAFE". Ski conference Norway, Nov 4th-5th 2014. Meeting for ethologists and vets.

Edwards SA & Baxter, EM. "Loose housing of lactating sows in Europe: future challenges and opportunities". Ski conference Norway, Nov 4th-5th 2014. Meeting for ethologists and vets.

Baxter, EM. "Biology and behaviour of pigs kept in natural and semi-natural conditions". BTSF (Better Training for Safer Food) Initiative. Training course on "Animal Welfare in pig production", Herning, Denmark, Oct 14th-17th, 2014. Training course for vets.

"Free Farrowing Systems for Sows – Important Features". CIWF China and EU Collaboration on Pig Welfare, London, September 24th 2014. Meeting for Chinese delegation.

"The great crate debate - developments in free farrowing research and commercialisation" was presented at the World Animal Welfare Day conference on October 4th 2013, hosted by SRUC at the Roslin Institute Building with a range of audience members including industry, government, academia and NGOs.

Workshops and consultations:

The project has been discussed at two industry meetings, organised by Rivalea Australia (November 2013) and the Danish Pig Research Centre (September 2013) and a critical review meeting organised by the National Pork Board in USA in January 2014. We are contributing to critical reviews and meta-analyses on farrowing and lactation systems that are being undertaken by the NPB, USA and Pork CRC, Australia.

FAWC Stakeholder meeting - FAWC study on the welfare implications of farrowing systems for sows and piglets, London, May 1st 2014. Contributions were made in writing, at the meeting and follow up requests for information for the report have been fulfilled.

Free Farrowing Workshop Vienna, Austria. December 8th-9th, 2011. Contributions made via abstracts and presentations. Edwards, SA chaired session "How should we classify loose farrowing systems to analyse critical components for success?" and closed meeting.

EFSA contributions: Baxter, E., Boyle, L., Edwards, S., Geers, R., Harris, M., Meunier Salaun, M.-C., Juul-Pedersen, L., Sutherland, M., Valros, A. and Wechsler, B., 2011. Sub-report A: Welfare of sow, boar and piglet. In: Spooler, H., Bracke, M. Mueller-Graf, C. and Edwards, S. (eds), Preparatory work for the future development of animal based measures for assessing the welfare of sow, boar and piglet including aspects related to pig castration. Supporting Publications 2011:0178 [868 pp.]. Available online: <http://www.efsa.europa.eu/en/supporting/pub/178e.htm>

Farm visits, document requests, website traffic:

Since the start of this phase of the project there have been 29 visits to view and discuss the PigSAFE system now running commercially at our research farms. The majority have been from industry (producers, supply chain, supermarkets), as well as visits from NGOs, academics and vets.

There have been over 45 consultancy requests, with six on-farm consultations travelling to different sites to discuss free farrowing options and/or to discuss ways of optimising performance via management or system design. The KTE documents (see Objective 1 i)) as well as other consultation materials have been provided to meet requests for information. The website is now suggested when requests are made. There have been 2600 visits to the website in the last eight months since its launch, with 1800 new users (i.e. different IP addresses). It is likely that much of this traffic has resulted from word of mouth. Specific links to the website from other websites (e.g. BPEX) have not been established yet but have been offered and once made will increase the "google ranking" (i.e. where the website appears when a search is made).

Website material is currently being translated by CIWF into Chinese, Italian and Greek for production of leaflets

regarding free farrowing.

Popular press and media:

“Loese soer skal have gode moderegenskaber (Loose Farrowing Requires Good Mothers)”. Svin Special nr 2 2014. Interview for Danish pig press.

Farming Today, BBC Radio 4 (recorded 11th April 2014)

PigSAFE Australia “promotional” video by Rivalea (2013) - <http://agav.co/pigsafesow>

“Management is the key to loose-farrowing”. PigWorld November 2012.

Countryfile, BBC. Screened Sunday 2nd December 2012.

“Pen tiedot ratkaiseva ilmaiseksi porsimisen (Pen details crucial in free farrowing)”. KMVET November 2012.

Why Free Farrowing? Animal Briefs. BSAS webpages. *With reviewer.*

Other:

PigSAFE pens as an “off the shelf” commercial package were displayed for the first time at the EuroTier, Hannover (15th-18th November) by AGE s.r.o (Czech pig building company) who now market them after approval of the design by the PigSAFE project team and intend to produce a containerised version. <http://www.age.cz/nweb-en/index.php/farm-for-pigs/sow-farrowing/housing-system/proven-non-crate-system-for-indoor-farrowing.html>

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

The following (academic) published outputs which include data from PigSAFE systems have been produced in the period since submission of the final report for Phase I of the AW0143 PigSAFE project in October 2011.

Peer-reviewed publications:

Martin, JE, Ison, SH & Baxter, EM. 2015. The influence of neonatal environment on piglet play behaviour and post-weaning social and cognitive development. *Applied Animal Behaviour Science*. 163, 69-79.

Edwards, S.A. & Baxter, E.M. 2015. Piglet mortality: causes and prevention. In *The gestating and lactating sow* (Farmer C, ed.). Wageningen Academic Publishers 2015, pp. 253-269. DOI 10.3920/978-90-8686-803-2_11

Ison, SH, Wood, CM & Baxter, EM. 2015. Pre-pubertal gilt behaviour during human interaction and startle object tests and the relationship with farrowing in conventional crates or PigSAFE pens. *Applied Animal Behaviour Science* - under review

Baxter EM, Adeleye OO, Jack M, Farish, M, Ison SH and Edwards SA. Achieving optimum farrowing performance in loose-housed systems in pigs – the effects of space and temperature. *Applied Animal Behaviour Science* – under review

Dwyer, C.M. & Baxter E.M. Neonatal mortality of farm livestock in extensive management systems. In *Animal Welfare in Extensive Systems* (Villalba J, ed.). Nottingham University Press. In press

Adeleye OO, Brett M, Blomfield D, Guy JH, Edwards SA. The effect of algal biomass supplementation in maternal diets on piglet survival in two housing systems. *Livestock Science* 2014, 162, 193-200.

Adeleye OO, Guy JH, Edwards SA. Exploratory behaviour and performance of piglets fed novel flavoured creep in two housing systems. *Animal Feed Science and Technology* 2014, 191, 91-97.

Seddon YM, Cain PJ, Guy JH, Edwards SA. Development of a spreadsheet based financial model for pig producers considering high welfare farrowing systems. *Livestock Science* 2013, 157(1), 317-321.

P.J. Cain, J.G. Guy, Y. Seddon, E.M. Baxter and S.E. Edwards. 2013. Estimating the economic impact of the adoption of novel non-crate sow farrowing systems in the UK. *International Journal of Agricultural Management*, 2 (2); 113-118

Guy JH, Cain P, Baxter EM, Seddon Y and Edwards SA 2012 Economic evaluation of high welfare indoor farrowing systems for pigs. *Animal Welfare* 21(S1): 19-24

In prep:

Seddon Y, Baxter EM, Brett M, Ross DW & Edwards SA. Achieving optimum performance in loose-housed systems in pigs – the effects of substrate and quiet.

Conference proceedings:

JH Guy, PJ Cain, YM Seddon, EM Baxter, GA Crook and SA Edwards. 2014. Impact of variability in capital cost and pig performance on adoption of free farrowing systems for sows: case studies from the UK and Australia. In *NJF-Seminar 476 Economics of Animal Health and Welfare: Heterogeneity, emerging issues and incentives for change*. 2-3 October 2014, Hämeenlinna, Finland, p. 13

Rebecca Morrison, Emma Baxter, Marianne Farish and Madeline Whyte. 2014. Loose farrowing sows- Piglet danger areas in summer. *ISAE Australia, New Zealand, Philippines and Africa regional meeting*, 29th

Oct, Sydney, Australia, p.16

Baxter EM & Edwards SA. Determining Piglet Survival. 2013. Keynote. Control of Porcine Reproduction IX, Olyztn, Poland, p1-16

R.S. Morrison, E.M. Baxter, M. Farish, B. McLeod and M.C. Whyte. 2013. The use of sloped walls in the dunging area of PigSAFE farrowing pens over summer. In Manipulating Pig Production XIV. APSA Biennial Conference, Melbourne, Victoria, Australia, 24th to 27th November, 2013, p221.

R.S. Morrison, M. Farish, M.C. Whyte and E.M. Baxter. Piglet mortality in the PigSAFE loose farrowing system compared to farrowing crates during autumn and winter. In Manipulating Pig Production XIV. APSA Biennial Conference, Melbourne, Victoria, Australia, 24th to 27th November, 2013, p35.

Baxter EM & Edwards SA. 2012. Piglet vitality and neonatal piglet losses. Keynote. Proceedings Proc 4th European Symposium on Porcine Health Management, Brugges, Belgium, p68-73

Edwards SA, Brett M, Ison S, Jack M, Seddon YM, Baxter EM. 2012. Design principles and practical evaluation of the PigSAFE free farrowing pen. Proceedings 4th European Symposium on Porcine Health Management, Brugges, Belgium. p113.

Edwards SA, Seddon Y, Rogusz A, Brett M, Ross D, Baxter EM. 2012. Optimising nest design for the PigSAFE free farrowing pen. Proceedings of the 46th Congress of the International Society for Applied Ethology, 31 July- 4 August 2012, Vienna, Austria, p95

Edwards SA & Baxter EM. 2012. Producing 2 tonnes of pigs per sow. Keynote. Advances in Pork Production, 23: 185-189. Proc of the 2012 Banff Pork Seminar, Banff, Canada, 17-20 January 2012

Edwards, SA & Baxter, EM. Piglet vitality: determinants and consequences for survival. Free Farrowing Workshop Vienna, Austria. December 8th-9th, 2011. pp21-24.

Edwards,S.A. & Baxter,E.M. 2011. Freedom farrowing. Proc Pig Veterinary Society, Newcastle.

Edwards,S.A., Brett,M., Guy,J.H. & Baxter,E.M. 2011. Practical evaluation of an indoor free farrowing system: the PigSAFE pen. 62nd Annual Meeting of the European Federation of Animal Science, Stavanger, Norway. p17.