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ANIMAL WELFARE AND ECONOMIC OPTIMISATION OF FARROWING SYSTEMS

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ABSTRACT

Currently, farrowing crates dominate indoor pig farrowing in the UK (~ 60% of herds). Such systems raise welfare problems due to close confinement of the sow. Although, many alternative housing systems have been developed in different countries, no commercially viable/feasible option has emerged for large-scale units. We have reviewed current scientific and practical knowledge of farrowing systems to identify alternative systems, their welfare and production potential. Our aim is to establish acceptable trade-offs between profit and welfare within alternative farrowing systems using linear programming, hence designing high welfare but commercially viable alternatives to the farrowing crate. System-specific results of interactions between welfare components and financial performances have been analysed and presented in this paper.

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KEY WORDS: alternative housing systems, animal welfare, economic optimisation, farrowing systems, pig

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INTRODUCTION

In 2006, around 73% of the 477,000 breeding sows in the UK farrowed in crates (Defra, 2007) raising welfare concerns. Development of an alternative, economical farrowing system that provides high sow and piglet welfare is regarded as beneficial for industry and the animals (Johnson and Marchant-Forde, 2009). Although, many alternative housing systems have been developed in different countries, no commercially viable/feasible indoor option has emerged for large-scale units. The main conflict, yet to be resolved, is between the sows' reproductive performance (profit) and sow/piglet welfare. This conflict is largely an issue of how to provide the appropriate level of environmental enrichment to meet the biological requirements of the farrowing sow given management and business constraints. Therefore, a study was initiated to: *i)* identify and investigate alternative indoor free farrowing systems which are commercially viable, and *ii)* to develop and redesign the farrowing environment from biological first principles to maximise welfare and production performances of piglets and sows. In this context, animal welfare scientists, engineers, expert stakeholder groups and economists worked together to synthesise information to identify a system prototype including potential innovations. A linear programming (LP) approach (Barnard and Nix, 1997) was used as a framework to test possible trade-offs between profit and welfare within alternative indoor farrowing systems. We studied conventional crates, simple pens and designed-pens (i.e. modified with separation of dunging and lying areas and addition of pen "furniture"), to explore the possibility of providing higher welfare within the context of commercially viable alternatives to farrowing crates. This paper outlines the LP framework used as part of the design process, highlighting the main issues arising at the biological/economic interface and first steps taken to address them.

MATERIALS AND METHODS

Optimisation model

LP uses technical coefficients to link key activities (e.g. farrowing and lactation) with resources they require such as feed, labour, space, power etc. This normally provides the physical input-output relationships determining profitability. The LP then chooses the combination of activities that maximises the objective (net margin at age 28 days (i.e. sales of weaners minus attributed fixed and variable costs)) subject to the resource constraints applied. However, in this case the welfare implications of the system chosen also needed to be incorporated. Biological needs of the sow and piglets during nest-building, parturition and lactation phases were therefore reviewed and three main "welfare components" (WC) namely space, substrate and temperature were identified. Baseline WC constraints and coefficients characteristic of each system were included in the LP. Activities were introduced (i.e. extra labour, space, power and substrate) to allow WC constraints to be relaxed (within limits of a given system) thus improving welfare and possibly productivity (reduced piglet mortality) at some additional expense. The LP would then enhance welfare within any system provided that the extra WC raised net margin. The cost of additional welfare beyond this point could be estimated using sensitivity analysis. SAC (2008) was used as the main source of financial/performance data for the conventional crate system. Quantitative values from 145 items of the reviewed literature were used to populate a database providing required data on the other studied farrowing systems.

LP details

The LP was implemented in Excel (Microsoft Corporation, 2002). As a first attempt at determining the relationships between WC coefficients and total piglet mortality, the related functions were assessed by the animal welfare scientists aiming at providing quantitative figures based on available scientific evidence rather than expert opinion. Assessing these relationships is, however, limited by the scarcity of relevant underlying data, thus introducing a degree of uncertainty about them and the model's outputs. Besides coefficients representing WC and piglet mortality relationships, input and output variables were distinguished. Input variables concern input on technical performance, such as litter size, piglet mortality and weaning rate (i.e. piglet to weaner flow). The average number of live piglets born per litter under the three systems studied was designated at 11.0. Initial corresponding total piglet mortality rates (including stillbirths), based on a summary of published surveys and experimental studies, were 19.8%, 20.6% and 16.54% for crate, pen and designed-pen respectively. The LP calculated a farm net margin for each system based on the average physical and financial assumptions/input data for the relevant set of WC. In parallel to this optimisation practice, a welfare score for each system is under development. The preliminary results are presented here.

RESULTS

LP derived total space per pen was 3.6, 11.1 and 7.0m^2 for crates, pens and designed-pens respectively (Figure 1). The LP utilised a higher amount of substrate in designed-pens than pens and crates. Crates with

6.9 and pens with 12.7 hours per sow per year had the lowest and highest labour requirements. Also the crates obtained the highest annual net margin (at weaners' age 28 days) per sow (£418) and the designed-pens and the pens with the net margins of £365 and £333 were in the second and third place (Figure 2). Taking account of both sow and piglet needs, the designed-pens obtained the highest welfare score of 2.39 whereas crates achieved a score of 1.25 which was slightly higher than the pens' welfare score of 1.03. These preliminary results suggest that, there is around 13% difference in net margin between crates and a designed-pen which provides higher welfare than farrowing crates. Further research is required to develop better WC coefficients and production performance relationships and to perform sensitivity analysis.

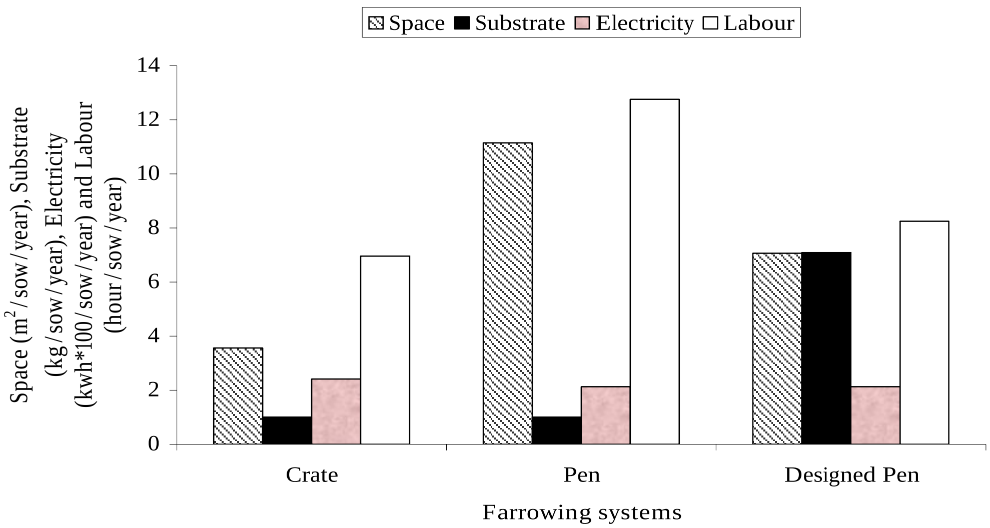

Figure 1. Total amount of inputs (per sow per year) used by the LP for the three farrowing systems.

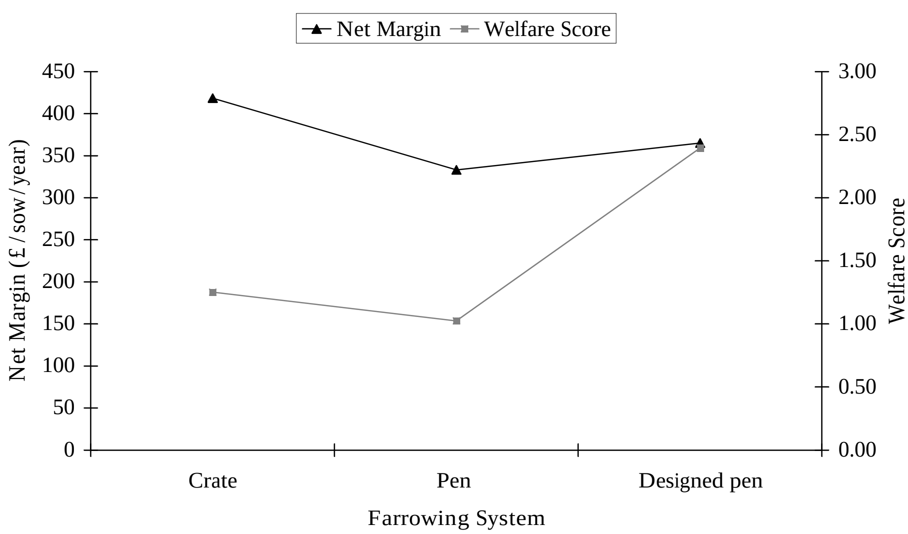

Figure 2. Graphical illustration of the optimised annual net margin/sow (at weaners' age 28 days) of the three studied farrowing systems against their associated welfare scores.

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