The economic and welfare impact of lameness in sows in England

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Abstract

Lameness in pigs is a major welfare concern and one of the most commonly reported reasons to premature culling of breeding sows. The prevalence of lameness in sows was estimated from 113 English pig breeding units and different risk factors associated with the occurrence of lameness were examined, followed by an assessment of the economic costs of lameness in sows. The prevalence of lameness in sows was 4.3%, and at least one lame sow was observed at 50.4 % of the 113 farms. In both indoor and outdoor sows, the presence of a prevention plan for lameness at the farm significantly affected the occurrence of lameness. Farms with higher producing sows were more likely to have a prevalence of lameness of 5% or higher. When only indoor sows were considered, the odds of lameness occurring at the farm increased with the number of sows in the pen. Lameness was also more likely to occur at farms where sows were housed on solid flooring than when they were kept on slatted or partly slatted flooring. Depending on the severity of the case, the estimated cost of an initial case of lameness could range from £19 to above £266. An increased awareness of the risk factors behind lameness is essential in farm management and can be useful when designing housing areas as well as developing future prevention plans for lameness.

Introduction

Lameness, the clinical presentation of impaired locomotion or abnormal gait, is an important concern for animal welfare in the swine industry (Anil *et al.,* 2007, KilBride *et al.,* 2009a). It is an indicator of pain which can cause distress and restrict the animal from performing

appropriate behaviour (KilBride *et al.,* 2009a; KilBride *et al.,* 2009b). Furthermore, lameness has economic implications for production. Lame animals are likely to feed less, leading to a lower growth rate. Lameness can also have consequences for fertility and lame sows are less likely to stand for mating. In addition, lameness is one of the most commonly reported causes after reproductive reasons for premature culling of breeding sows (Anil *et al.,* 2005; Anil *et al.,* 2007; KilBride *et al.,* 2009a). The most common causes of lameness in sows are infectious arthritis and osteochondriosis (Scott *et al*., 2006, as cited by KilBride *et al.,* 2009b). Nevertheless, there appears to be an association between the prevalence of limb lesions and lameness (KilBride *et al.,* 2009a; KilBride *et al.,* 2009b), and 5-20% of lameness cases are believed to be connected to foot or limb lesions (Kirk *et al.,* 2005, as cited by KilBride *et al.,* 2009b)

KilBride *et al.* (2009a) observed abnormal gait in 16.9% of pregnant sows in England. Other cross-sectional studies have detected prevalences of lameness in sows ranging from 8.8% in Finland (Heinonen *et al.,* 2006, as cited by KilBride *et al.,* 2009a) to 15% in Denmark (Bonde *et al.,* 2004, as cited by KilBride *et al.,* 2009a), possibly due to different housing and management systems. The housing conditions pigs are kept in affect their health and welfare. A study carried out in England in 2003/2004 showed that 80% of sows were housed on solid concrete floor, 6% on partly slatted floor, 2% on fully slatted floor and 12% were kept outdoors (KilBride *et al.,* 2009b). There seems to be an increased risk of lameness in sows housed on slatted floor compared to sows housed on solid concrete floor with bedding or outdoors on soil (KilBride *et al.,* 2009a). KilBride *et al.* (2009b) found that the prevalence of lameness was four times higher in pregnant sows housed on partly slatted or fully slatted floor compared with pregnant sows housed on solid concrete with deep bedding or sows in outdoor housing on soil (KilBride *et al.,* 2009b). Slatted floors are less labour intensive as they do not require manual removal of dung and may, therefore, lead to lower production costs (KilBride *et al.,* 2009b). Nevertheless, there are costs to treating cases of lameness and replacing breeding sows removed due to lameness. Identifying risk factors associated with lameness is essential to prevent clinical cases of lameness. Effective prevention and management of lameness in pig breeding farms would not only improve the welfare of breeding sows but also improve production and reduce the costs of treatment and culling of sows due to lameness. With increasing production costs in the British pig industry over the last ten years and increasing competition from member countries of the European Union with lower market

prices (Environment, Food and Rural Affairs Committee, 2008), cost-effective farm management without compromising the welfare of the animals is essential.

The objectives of the following study were to estimate the prevalence of lameness in sows in England, to investigate risk factors associated with lameness in sows and to assess the economic impact of lameness.

Methods

Study area and British pig industry

In 2009, the British pig population consisted of approximately 470,000 breeding sows (Environment, Food and Rural Affairs Committee, 2008). Modern commercial farms are most predominant, constituting 92% of the pig breeding farms (Environment, Food and Rural Affairs Committee, 2008). Farms may be specialized in breeding or finishing pigs or they may have both (BPEX, Year unknown). The majority of British pig farms are located in England (82%) with the highest density of pig farms in east of England (Environment, Food and Rural Affairs Committee, 2008). The average pig herd size on commercial breeding farms is 500 breeding sows (Environment, Food and Rural Affairs Committee, 2008). According to English legislation, dry sows must be kept in group housing (Statutory Instruments, 2007).

Data collection

Data of lameness in dry sows were collected from 113 pig breeding farms in England in 2007 and 2008. At each farm, a pen was randomly selected and 20 sows were randomly chosen and observed as a group for 10 minutes as well as individually. Pigs were considered lame if they displayed shortened stride, swaggering of hindquarters while walking, reduced weight bearing on affected limb, reluctance to move or get up, arched spine when walking or standing or obvious head nods when walking.

For each group, housing conditions were recorded and the dimensions of the pen and building were measured. Information about the management system was obtained from the farmer. The data were collected by veterinary students during Animal Husbandry placements. All observers had received previous training in pig examination and data collection.

Prevalence of lameness in sows

The prevalence (p) of lameness in sows was calculated as follows:

$$\frac{\qquad\qquad\qquad\qquad}{\qquad\qquad\qquad\qquad}$$

The number of sows culled due to lameness was obtained from the farm records and used to estimate the yearly turnover rate of sows due to lameness:

$$\frac{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}$$

It was assumed that the number of sows did not vary significantly over the year.

Risk factor analysis

To assess the risk factors associated with the occurrence of lameness in breeding pig farms, generalised linear models with logit transformation and a binomial error structure were developed. If a farm had a lameness prevalence of 5% or above, the farm was considered positive for lameness.

Fisher's Exact test was used to establish which categorical variables explained variation in the occurrence of lameness alone. Univariable logistic regression analysis was used to determine which continuous variables explained variation in the occurrence of lameness individually. Variables were included in the multivariable logistic regression analysis if they were significant at $P < 0.2$ (KilBride *et al.,* 2009a). Explanatory variables considered in the risk factor analysis are listed in Table 1. At the end, all variables eliminated during the screening of association were added to the final model to check for confounding.

First, a model was built that assessed the prevalence of lameness in farms with sows housed either indoors or outdoors. Then a separate model was constructed to compare the effect of different housing conditions in indoor pens. For both models, variables contributing the least to the model were eliminated sequentially to identify the most parsimonious model. Pearson's correlation coefficient was used to assess the direction of any correlation between the occurrence of lameness and the explanatory variables.

Data were managed in Microsoft Access 2007 and statistical analyses were performed in R 2.12.1 (R Development Core Team, 2010).

Economic assessment

Direct and indirect costs associated with lameness in sows were identified through a literature review and combined with statistic values from the study to estimate the cost of of lameness in breeding sows.

Results

In total, data were collected from 113 breeding pig farms. The mean heard size was 483 breeding sows (range 32-2,200 sows), and the mean number of pigs per pen was 42 (range 4 – 366). In 43% of the farms, the sows were housed indoors, in 53% the sows were housed outdoors, and in the remaining 4% the housing was either mixed or unknown. Out of the pigs housed indoors, 83% were kept on solid floor, 11% on partly slatted floor, and 6% on fully slatted floor. There were written plans for preventing lameness in 53% of the 113 farms and 65% had written plans for treating lameness. Organic standards were followed at 3.5% of the farms.

The prevalence of lameness was calculated from 2,260 sows. Out of the 2,260 sows, 4.3% exhibited signs of lameness, such as shortened stride, swaggering of hindquarters while walking, reduced weight bearing on affected limbs, reluctance to move, arched spine when standing or walking, or obvious head nods when walking. At least one lame sow was observed at 50.4 % of the 113 farms. The prevalence of lameness was only slightly higher in sows housed indoors (4.4%) than sows housed outdoors (4.3%).

A total of 80 farms out of the 113 farms (71%) had records of sows culled per year due to lameness. The estimated culling rate due to lameness was 3.9%, with a mean of sows culled per year due to lameness of 20 sows per farm.

General linear models of risk factors associated with lameness

When both farms with indoor and outdoor housed sows were considered, the presence of a prevention plan for lameness at the farm significantly affected the occurrence of lameness (P=0.04), where the odds of lameness occurring at a prevalence of 5% or higher were 0.44

lower at farms with a prevention plan for lameness than the odds at farms with no plan for preventing lameness. In addition, farms where more piglets were born alive per sow per year were more likely to have a prevalence of lameness of 5% or higher (P=0.02), where the odds ratio (OR) of lameness increased by 2.1 for every 10 piglets that were born alive per sow per year.

When only farms with sows housed indoors where considered in the analysis, the number of pigs in the pen (P=0.05), the type of flooring (P=0.03), and the presence of a prevention plan (P=0.02) were statistically significant. The OR of lameness augmented by 4.0 per 100 sows that were added to the pen. The odds of having a lameness prevalence of 5% or above were lower in sows housed on partly or fully slatted floor than animals kept on completely solid flooring (OR=0.04). Similarly to the analysis in which indoor and outdoor housed pigs were combined, the odds of lameness occurring were lower in farms with written prevention plans for lameness than those without (OR=0.16).

Economic assessment

Potential costs due to lameness in sows are shown in Figure 1. Table 2 shows an estimate of potential costs associated with a case of lameness.

Early removal of sows due to lameness results in lower number of litters and weaned piglets per sow per year (reviewed in Anil *et al.,* 2005). A German study found that lame sows had at least one and a half fewer litters than healthy lame sows (Grandjot, 2007, as cited by Anil *et al.,* 2009). In addition, loss of piglets was 15% higher for lame sows than non-lame sows (Grandjot, 2007, as cited by Anil *et al.,* 2009). To estimate the cost of reduced production, the value of pigs at weaning was estimated by adjusting the sale value per kg of rearing and finishing pigs for the weight at weaning (Dhuyvetter, 1996) followed by discounting the inputs saved from not producing lost weaners and additional sow feed saved during lactation. By using the reduction in litters produced and the loss of piglets in lame sows deduced by Grandjot (2007, as cited by Anil *et al.,* 2009**),** the estimated cost of reduced production due to lameness was £84 in indoor sows and £60 in outdoor sows per case. The estimates should include any extension in the time period from farrowing-to-conception as this directly affects the number of litters born per year. The cost of additional services is, however, not included and more data regarding the effect of lameness on the farrowing-to-conception time period would be necessary for a more accurate estimate.

The medication required and time spent on treating a case of lameness depends on the underlying cause. Lame pigs should be isolated with deep bedding. Medication can include anti-inflammatory analgesics and antibiotics. If a lame sow requires 45 minutes of additional attention by the stockman and 5 minutes by a veterinarian, the cost of labour due to lameness would be £13. Including the cost of drugs, bandage and labour, the estimated cost of treatment was £19. Costs of repeated treatments, additional foot trims and hospital pen were not included.

If the sow is culled as a consequence of lameness, the estimated cost is £39 if the cost of the replacement gilt and transport are considered, assuming a sow market price of £0.74/kg and an average carcass weight of 153 kg. In severe cases, immediate euthanasia may be required (NADIS, 2010), where the cost increases to £162.

Thus, depending on the severity of the case and the subsequent outcome, the cost of an initial case of lameness could range from £19 if only treatment is required to above £266 in more severe cases where the production level is affected and euthanasia is necessary.

Discussion

In this study, the prevalence of lameness in sows in England was estimated and associated risk factors were assessed. The estimated prevalence of lameness in sows was 4.3%, which is lower than the prevalence of 16.9% in pregnant sows reported by (KilBride *et al.*, 2009a). Out of the herds included in this study, 43% were housed indoors and 53% were housed outdoors. Nationally, 70% of breeding sows are housed indoors and 30% are kept outdoors (BPEX, Year unknown). However, the 2003/2004 Warwick study (KilBride *et al.*, 2009b) found that only 12% of gilts and pregnant sows were housed outdoors. In other studies, the prevalence of foot and limb injuries has been significantly higher in pigs housed indoors than outdoors (KilBride *et al.*, 2009b). The overrepresentation of sows housed outdoors in this study may have contributed to the lower prevalence of lameness observed compared to previous studies. Nevertheless, although the prevalence of lameness was slightly higher in sows housed indoors than sows housed outdoors, the difference was not statistically significant.

Some studies show that the prevalence of lameness is higher in the winter and the odds of a sow being culled due to lameness are higher in non-summer months than in summer months (Anil *et al.,* 2005). In this study, 78% of the observations took place during the summer months (June-September) and the remaining 22% took place in the spring (March-April) and the estimated prevalence of lameness may, therefore, be lower than if the study would have taken place in the winter months. Variation in prevalence estimates between studies may also depend on the case definition of lameness (KilBride *et al.,* 2009a).

When sows housed both indoors and outdoors sows were considered, the presence of a written lameness prevention plan was significantly associated with the occurrence of lameness at a farm. This suggests that raised awareness of lameness prevention effectively reduces the prevalence of lameness in pig breeding units and highlights the importance of having a lameness prevention strategy. In addition, the odds of lameness occurring was significantly higher at farms with higher producing sows. In cattle, higher producing dairy cows are more likely to suffer from lameness (Willshire and Bell, 2009) and the increased weight during gestation might make higher producing sows more prone to lameness

When only sows housed indoors where included in the analysis, the number of sows in the pen and the flooring type were also significantly associated with the occurrence of lameness. Lameness was positively associated with the number of sows in the pen but was not significantly associated with stocking density, suggesting that it is related to group behaviour rather than space restriction. For instance, more aggression tends to occur in larger groups to establish hierarchy ranks, especially at the time of regrouping (Arey and Edwards, 1998). In addition, it may be harder for the stockman to identify cases of lameness in a larger group of sows. Although a severely lame sow can be easily spotted, mildly lame sows might be difficult to distinguish from healthy sows (Anil *et al.,* 2009).

In sows housed indoors, the odds of lameness occurring was higher in sows housed on solid flooring than sows housed on partly slatted or fully slatted floor. Previously, higher prevalence of lameness has frequently been reported in sows housed on slatted floor compared to completely solid floor (KilBride *et al.,* 2009a; KilBride *et al.,* 2009b). However, KilBride *et al.* (2009b) found that piglets kept on slatted floors have less lesions than piglets kept on solid concrete and Kreiter *et al.* (2004, as cited by KilBride *et al.,* 2009a) reported a lower prevalence of lameness in finishing pigs that were housed on slatted floors than pigs

housed on solid floors. It seems as if there is no indoor housing system that is optimal for all production stages and a partly slatted floor has been suggested as possible compromise (KilBride *et al.,* 2009b). In this study, a higher proportion of the sows where housed on partly slatted floor than fully slatted floor. Compared to a fully slatted floor, partly slatted flooring provides increased weightbearing surface area in the solid compartment where the sow can lie down, reducing the pressure on the skin (KilBride *et al.,* 2009b), at the same time as moist and dung are removed more effectively and could contribute to healthier limbs and feet.

The culling rate of sows due to lameness (3.9%) was slightly lower than the prevalence of lameness in sows (4.3%). Other studies have reported annual removal rates of 11% to 14% due to lameness (reviewed in Engblom *et al.,* 2007). Production systems are most profitable when the replacement rate is low, and the highest annual productivity is achieved when sows are removed due to old age (Engblom *et al.,* 2007). Lameness can impede sows from reaching optimal breeding efficacy (Anil *et al.,* 2005). The optimal economic life span of sows allows for five parities, and a minimum of three litters are required from a sow to be profitable (reviewed in Engblom *et al.,* 2007). Sows culled due to lameness are often removed at a younger age than sows removed for other reasons, increasing the cost per weaned pig as the number of litters per sow per year and the number of piglets weaned per sow per year decreases (Anil *et al.,* 2005).

In cattle, 82% of the cost of lameness is associated with reduced fertility (Willshire and Bell, 2009). In this study, there was no significant decrease in the number of litters or number of piglets born per sow per year associated with lameness. Nevertheless, estimating the reduction in fertility due to lameness is difficult since higher producing animals can be more prone to become lame. To obtain more reliable estimates of reduced production due to lameness, the loss in production relative to the predicted production levels of the affected individual should be used instead of the population mean (Willshire and Bell, 2009).

The cost of pig production in the UK is high compared to many other countries in the European Union (EU), much due to higher feed prices but also as a consequence of lower sow productivity and carcass weight (Fowler, 2008). On average, 1 hour and 7 minutes is spent on each pig in labour per year in the UK, which is 8 minutes more than the EU average, reflecting the poorer physical performance in British pigs (Fowler, 2008) and demonstrating the need to prioritise preventable health issues.

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Tables

Table 1. Explanatory variables considered in the risk factor analysis of lameness occurrence in sows.

Housing conditions
animals/pen
area of pen
stocking density
floor type (solid or partly slatted/fully slatted)
presence of bedding
bedding type
bedding coverage
Production
sows with more than six litters
sows with less than two litters
litters/sow/year
piglets born alive/sow/year
piglets weaned/sow/year
Farm management and prevention plans
sows in care of stockman
total number of pigs in care of stockman
written plans to prevent lameness present
written plans for treating lameness present
participation in any Farm Assurance scheme

Table 2. Potential costs associated with an initial case of lameness. Where available, summary statistics from the study were used and integrated with reported values.

Costs of reduced production	**Indoor**	**Outdoor**
Fewer litters produced	-75.40	-53.98
Piglet loss/litter	-8.51	-6.33
Total	**-83.91**	**-60.31**
Costs of treatment		
drug treatment (Archer *et al.,* 2010)	-17.50	
bandage (Archer *et al*., 2010)	-1.65	
Labour	-12.75	
Total	**-19.15**	
Costs of labour		
stockman (£/hour) (Fowler, 2008)	9.25	
veterinarian (£/hour) (Willshire and Bell, 2009)	70.00	
Costs of euthanasia		
cost of replacement gilt (Rodríguez *et al.,* 2011)	-150.00	
disposal of carcass (ERAD, 2003)	-12.50	
Total	**-162.50**	
Costs of cull		
cost of replacement gilt (Rodríguez *et al*., 2011)	-150.00	
slaughter price	113.22	
transport to slaughter (Fowler, 2008)	-2.50	
Total	**-39.28**	

Summary statistics	**Mean**	**SD**
litters/sow/year	2.3	0.2
pigs born alive/sow/year	21.0	6.9
pigs borne alive/litter	9.1	2.8
pigs weaned/sow/year	19.3	5.5
pigs weaned/litter	8.4	2.2
Outdoor production		
cost per pig reared to weaning (£) (BPEX, 2010)	8.85	
weaning age (days) (BPEX, 2010)	26	
weaning weight (kg) (BPEX, 2010)	7.08	
Indoor production		
cost per pig reared to weaning (£) (BPEX, 2010)	7.69	
weaning age (days) (BPEX, 2010)	27	
weaning weight (kg) (BPEX, 2010)	7.37	
sale value per kg (£) (BPEX, 2010)	1.96	
sow dressed carcass weight (BPEX, 2010)	153	
sow market (£ per kg) (BPEX, 2010)	0.74	
increase feed intake during lacatation (kg/day) (Eissen *et al.,* 2000)	2.25	
sow feed (£/kg) (BPEX, 2010)	0.16	

Figures

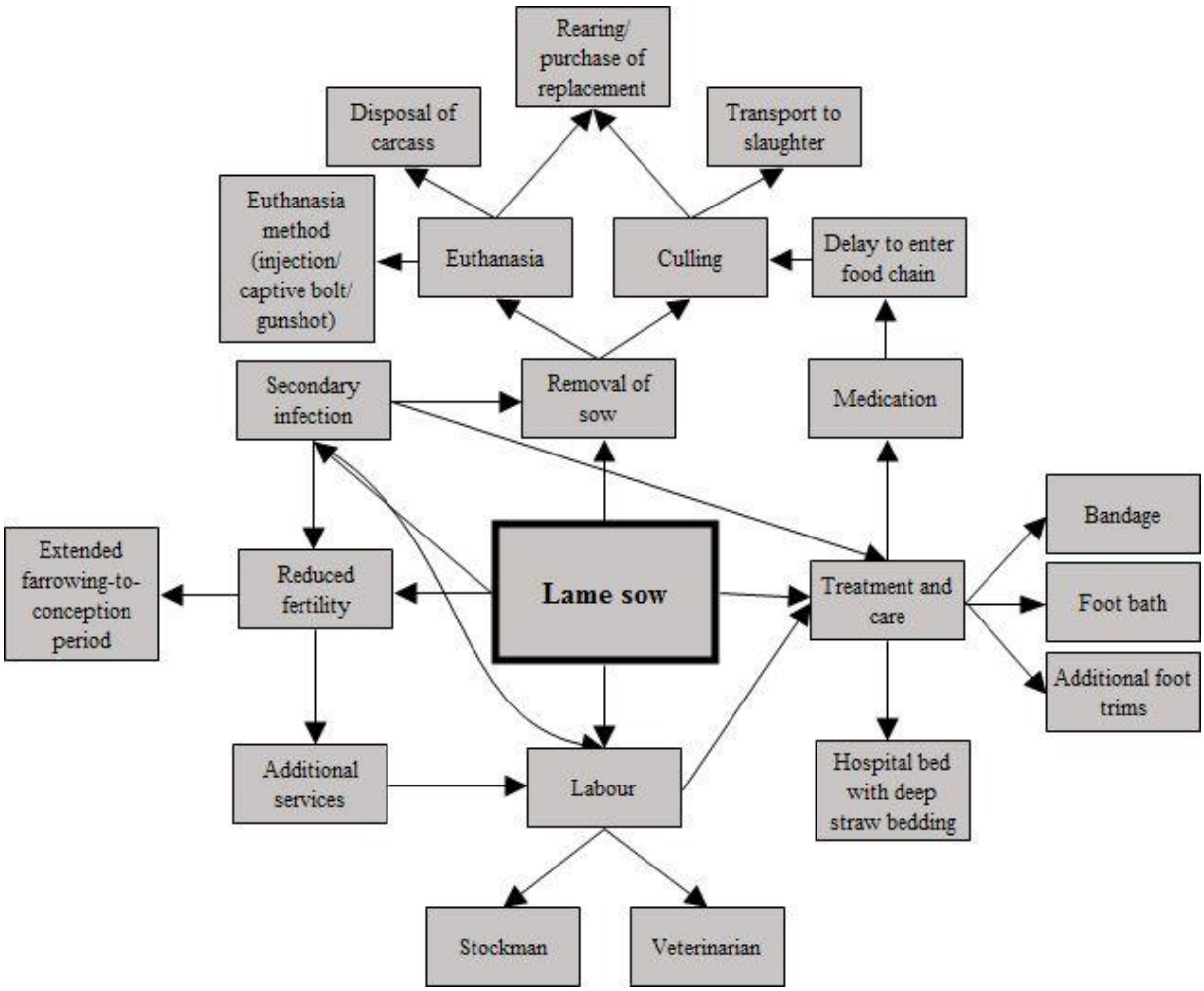

Figure 1. Concept map of costs associated with initial lameness in sows.