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ECONOMIC VALUES FOR FARROWING RATE TO IMPROVE SEASONAL FERTILITY

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SUMMARY

Seasonal fertility is the variation in reproductive performance of sows across different seasons. A consistent fertility of sows across seasons is desirable. Seasonal fertility is reflected in farrowing rate because a reduction in farrowing rate is often observed during the summer-autumn period. An independent economic model was developed to derive economic values for farrowing rate. Economic values varied from $2.19 to $1.95 per 1% change in farrowing rate for mean farrowing rates of 72 to 85%. The economic value for farrowing rate predominately accounted for the costs of non-productive days of non-pregnant sows. The model and economic values presented in this study for farrowing rate can be used to extend existing maternal breeding objectives in pigs. Further, the variation in economic values for farrowing rates can be used to consider genotype by season interactions for farrowing rate in pig breeding programs.

INTRODUCTION

Seasonal fertility is the variation in a fertility measure such as farrowing rate or litter size across different seasons and low seasonal fertility is desirable. Historically, research has focused on seasonal infertility which is characterised by poorer reproductive performance of sows during the summer and autumn period (e.g. Love *et al*. 1993; Auvigne *et al*. 2010). In contrast, a focus on seasonal fertility extends seasonal infertility because seasonal fertility aims to improve the consistency of high reproductive performance of sows across all seasons rather than focusing on reduced performance of sows in one season only.

Selection of sows across seasons for reproductive traits is expected to improve seasonal fertility somewhat. For example, a maternal line selected in hot and tropical environments across countries was better adapted to high temperatures than a line selected in one temperate environment only (Bloemhof *et al.* 2008). However, incorporating genetic variation in the response of sows to changes in seasonal conditions in breeding objectives enables more targeted selection for seasonal fertility.

A key trait to quantify seasonal fertility is farrowing rate which represents the proportion of sows served that farrow. Genetic variation in the response of sows to changes in photoperiod and ambient temperature has been found for farrowing rate (Sevillano *et al*. 2016). Further, farrowing rate was genetically a different trait in different temperature groupings in the Australian study by Bunz *et al*. (2019). These results support the inclusion of genotype by season interactions for farrowing rate in order to enhance genetic gain in seasonal fertility of sows. It was the aim of this study to derive economic values for farrowing rate taking into account differences in the level of performance for farrowing rate as they may be observed across seasons.

MATERIALS AND METHODS

Farrowing rate is a binary trait and variance components may be based on the original scale (0 versus 1) or may be expressed as a percentage (0 versus 100). Production systems usually refer to changes in farrowing rate in 1% increments which was the basis of the model that was developed to

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derive the economic value of farrowing rate. A higher farrowing rate improves profit by reducing costs of non-productive days of sows in each parity and reducing costs associated with each mating. Non-productive days arise for sows that fail to farrow by returning from a mating and for non-pregnant sows in general until they are removed from the herd.

The economic value for a 1% increase in farrowing rate (EV_FR) was calculated as: EV_FR = (ScreturnFR + ScmatingFR) – (ScreturnFR+1% + ScmatingFR+1%), where ScreturnFR are the costs to keep a returned sow (e.g. non-pregnant sow) in the herd until the sow is either mated again or removed from the herd assuming a base farrowing rate and ScmatingFR are the additional mating costs of returned sows ($ 30/mating) for the same assumed base farrowing rate. Both ScretrurnFR+1% and ScmatingFR+1% are the corresponding costs associated with a farrowing rate that is 1% higher than the assumed base farrowing rate.

The costs of keeping returned sows in the herd for the base farrowing rate depend on feed, housing and labour costs as well as the average number of days until a returned sow is either successfully remated or removed from the herd. Key assumptions made in the calculation of the economic value for farrowing rate were based on typical production parameters for Australia (Australian Pork Limited 2012a). These include production levels of sows, price assumptions for feed as well as those that relate to other aspects of the operation, including capital value of the buildings and facilities as assumed by Amer *et al.* (2014).

The daily costs per sow (dSc) were the sum of daily feed costs (dFc), daily housing costs (dHc) and daily labour costs (dLc) which were derived as: dFc = feed per day (kg) * costs of feed ($ / kg); dHc = (costs of sow place ($ / place) * annual interest rate (%) + costs of sow place ($ / place) * annual depreciation rate (%)) / 365; dLc = (labour costs per staff ($ / annum)/ number of sows per staff (n sows)) / 365.

The average number of days until a returned sow is either successfully remated or removed from the herd for the base farrowing rate depends on the proportion of sows that a) farrowed from each mating (n = 1 to 4) and b) were not pregnant or not-in-pig (NIPs) and subsequently removed from the herd. The NIPs were calculated as: NIPs = (1 – FR) * NIPs%, where FR is farrowing rate and NIPs% is the percentage of NIPs (12%) of returned sows from each mating (Australian Pork Limited 2012b).

The proportion of sows that farrowed from each mating (psow) was calculated as: $psow_n = (psow_{n-1} - NIPs)*FR$.

The costs of keeping returned sows in the herd were: ScreturnFR = NIPs * NIPsdays * dSc + $\sum_{n=2}^{4}(21 * psow_n * dSc + cmate)$, where cmate were costs of mating including semen costs and labour ($ 30 / mating). A mating interval of 21 days and removal of NIPs at 80 days after mating (NIPsdays) were assumed.

RESULTS AND DISCUSSION

Costs. The daily costs to keep a sow in the herd were $4.73 $ per day (Table 1). Housing costs accounted for the largest cost component with $2.63 per day, reflecting the high capital costs of buildings in Australia. Comparison with costs structures outlined for other countries overseas (e.g. Krupa *et al.* 2017) are not possible because housing costs were not reported specifically and were part of other non-feed costs which were outlined for groups of animals of a full farrow-to-finish unit and not specifically defined for sows.

The proportion of sows that farrowed from the 2nd to the 4th mating for different farrowing rates are shown in Table 2. These percentages of sows farrowing from different matings and the corresponding NIPs corresponded to industry values (Australian Pork Limited 2012b).

Economic values. Economic values for farrowing rate were derived for different levels of farrowing rate using the base assumptions outlined above. The economic value for farrowing rate varied from $ 2.19 per 1% improvement for a low farrowing rate of 72% to $ 1.95 per 1%

improvement for a high farrowing rate of 85% (Table 3). The intermediate value of $ 2.06 may be appropriate for most farms as an overall average across the year, while the higher economic value may be more applicable for the summer-autumn period when farrowing rates are usually lower.

Table 1. Daily costs per sow ($/day) due to feed, housing and labour

Cost component	Item	Input value	Costs per sow
	Daily feed per sow (kg)	2.5	
	Costs of feed ($/kg)	0.4	
Feed costs			1.00
	Costs of sow place ($)	8,000	
	Interest rate (%)	7	
	Depreciation rate (%)	5	
Housing costs			2.63
	Annual costs per staff ($)	60,000	
	Sows per staff	150	
Labour costs			1.10
Total daily costs per sow			**4.73**

Table 2. Percentage of sows farrowing from the second to fourth mating and percentage of non-pregnant sows (not-in-pig sows, NIPs) for different farrowing rates

Percentage of sows that farrow after	Farrowing rate (%)					
	72.0	75.0	77.0	80.0	82.0	85.0
2nd mating (%)	17.7	16.5	15.6	14.1	13.0	11.2
3rd mating (%)	5.0	4.1	3.6	2.8	2.3	1.7
4th mating (%)	1.4	1.0	0.8	0.6	0.4	0.3
Percentage of NIPs (%)	3.4	3.0	2.8	2.4	2.2	1.8

Sensitivity analyses showed the effect of modifying assumptions in housing costs and number of sows per person on economic values for farrowing rate (Table 3). Capital costs due to housing were the biggest cost component and changes in these costs affected economic values for farrowing rate most. The range of these economic values may be used to define the economic value for farrowing rate that is most appropriate for specific conditions observed on commercial farms.

This study extends the number of traits included in maternal breeding objectives for pigs outlined by Amer *et al.* (2014). The approach of using independent models for each trait improves the feasibility of extending breeding objectives. The economic value for farrowing rate mainly reflects costs of non-productive traits in sows complementing economic values for age at first oestrus and weaning to conception interval which also describes variation in non-productive days of gilts and sows as outlined by Amer *et al.* (2014). A longer farrowing interval, however, is also associated with higher culling rates of sows that ultimately result in poorer sow longevity. The economic value for sow longevity outlined by Amer *et al.* (2014) was derived from net returns and replacement costs of sows resulting from a 1% increase in survival of sows in each parity which was independent from the costs of non-productive days due to changes in farrowing rate.

Economic values for farrowing rate were not found in the literature. The model presented by de Vries (1989) has been widely used in pig breeding programs. The model considered culling rate of sows as breeding objective traits. Culling rates were defined for different stages of the reproductive cycle of sows including the stage from mating to farrowing. The number of non-productive days was constant in each stage, and culling rates effectively described sow longevity as illustrated by the author, who derived an economic value for sow longevity based on the association between culling rates and the number of farrowings per replacement gilt used in their model.

Table 3. Economic values for farrowing rate ($ / 1%) assuming different levels of farrowing rate and alternative input values for housing and labour costs that vary from the base value by plus or minus 25%

	Farrowing rate (%)					
	72.0	75.0	77.0	80.0	82.0	85.0
Base assumptions	2.19	2.15	2.12	2.06	2.02	1.95
Base and $10,000 per sow place	2.44	2.40	2.36	2.30	2.25	2.17
Base and $6,000 per sow place	1.94	1.91	1.88	1.83	1.79	1.73
Base and 112.5 sows per person	2.33	2.29	2.25	2.19	2.15	2.07
Base and 187.5 sows per person	2.11	2.07	2.04	1.98	1.94	1.88

Breeding objective. A breeding objective may consider farrowing rate as one trait, assuming that it is the same trait throughout the year. However, farrowing rate should be considered as a different trait in the hot summer-autumn period versus other seasons, given the genetic parameters estimated by Bunz *et al.* (2019). This can be accommodated in breeding objectives by defining farrowing rate as a separate trait for two separate seasons (hot summer-autumn versus other seasons) given the result by Bunz *et al.* (2019). Defining farrowing rate as a different trait for two seasons requires using appropriate economic values for each season taking differences in farrowing rate across seasons into account. The economic value for farrowing rate applicable to each season should then be weighted by the proportion of sows represented in each season. In the study by Bunz *et al.* (2019) about 24% of sows were mated in the hot summer-autumn period leaving 76% of sows for the other seasons.

CONCLUSIONS

An independent economic model was developed and used to derive economic values for farrowing rate enabling the extension of maternal breeding objectives in pigs. Economic values for farrowing rate were higher for lower farrowing rates, which may be observed in the summer-autumn season. These higher economic values for lower farrowing rates may be used to consider genotype by season interactions for farrowing rate in pig breeding programs.

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