Breeding for improved calving performance in Piemontese cattle - economic value

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Abstract

Economic values for calving performance in first and later parities were estimated for the Piemontese cattle. Calving performance is a threshold trait usually recorded using a scoring system with categories corresponding to the rate of difficulty. In the Piemontese breed five categories were adopted (from unassisted to foetotomy). A normal underlying distribution with thresholds corresponding to used categories was assumed. A cost function, expressing the extra costs of difficult calving and Caesarean sections with respect to normal calving, was defined. Costs included veterinary fees, additional labour, increased stillbirth rates, reduced fertility and involuntary culling of cows as a consequence of a difficult calving. Cost of an average case of dystocia in first parity was 61.8 Euro and 22.1 Euro for male and female calves, respectively. Corresponding costs in later parities were 34.2 Euro and 11.4 Euro. Dystocia showed a great economic incidence mostly when male calves were born from first calving cows. Economic values were computed as marginal increase of the cost function for a marginal increase in the normal underlying distribution. Economic values for calving performance were -1.02 Euro in first parity and -0.42 Euro in later parities per a 1% increase of dystocia. In first parity the economic value of calving performance was two times greater than in subsequent parities suggesting that, also from an economic standpoint, calving performance in the first and later parities should be considered as different traits.

1. Introduction

Calving performance is a trait of considerable economic importance in cattle breeding programmes, especially for high muscled beef breeds, showing relatively high incidence of calving difficulties. Dystocia is defined as difficulty in giving birth. Dystocia affects profitability of the farms generating additional costs compared to normal calving. Costs are related to veterinary fee, increased labour for the farmer, loss of the calf, but also to health and fertility problems of the cow after the calving, resulting in reduced productivity (Meijering, 1986).

Calving performance is a threshold trait resulting from subjective scoring of the calving into categories corresponding to the rate of difficulty. Usually 4 to 6 classes are used depending on the country and the cattle breed considered. Categorical traits have a normal underlying continuity with thresholds imposing a discontinuity on the visible phenotypes, usually called liability scale (Falconer and Mackay, 1996). A methodology to compute the economic value of calving performance considered as a categorical trait has been provided by Meijering (1986) and then applied by other authors (Bekman and Van Arendonk, 1993; Dekkers, 1994; Groen *et al*., 1995). The economic value of calving

performance is mainly dependent on the frequency of animals in the classes used to score difficult calving (hard pull, Caesarean section, foetotomy) and the costs of veterinary fee and calf loss in these classes (Groen *et al.*, 1997). Meijering (1986) and Bekman and Van Arendonk (1993) showed the sensitivity of the economic value of calving performance to calf prices and incidence level of dystocia in Holstein cattle. In very few cases the economic value of calving performance has been derived for beef cattle (Koots and Gibson, 1998).

Heterogeneity of variance components across parities (Weller *et al.*, 1988; Cue and Hayes, 1985) suggested to consider calving performance in first and later parities as different traits, leading also to compute different economic values (Dekkers, 1994; Koots and Gibson, 1998).

Direct and maternal components of calving performance have the same economic value, but different economic importance arising from differences in rate and timing of expression of superior genes (Dekkers, 1994).

This study focused on the derivation of the economic value of calving performance for first and later parities in Piemontese cattle.

2. Material and methods

The data used for this study were 60,833 records of first calving and 148,504 records from second up to fifth parity of Piemontese cows. Each record consisted of dam identification, date of the calving, parity of the dam, sex of the calf, calving score and viability. In the Piemontese breed five classes were used to score calving performance:

1 unassisted delivery,
2 easy calving,
3 difficult calving,
3 Caesarean section,
4 foetotomy.

Considered costs were veterinary fee, labour of the farmer, loss of the calf, reduced fertility and increased culling rate as a consequence of a difficult calving. Economic parameters used in this study, derived from market prices or supplied by veterinarians and Piemontese extension specialists, are reported in Table 1. Cost components were considered for calving score categories 3, 4 and 5, expressed as a difference from the cost of an easy calving (calving score 2) assumed to be the basic situation, according the sex of the calf and the parity of the dam (first or later parities).

Costs of calf loss was computed considering stillbirth rates and calf price. Calving intervals were used to assess the costs of reduced fertility. Costs of the heifers, residual value of fattened cows for the slaughterhouse and culling rates were included in the estimation of the costs of involuntary culling.

Table 1. **Economic parameters assumed in the computation of costs for dystocia in Euros**

Parameter	Value
Cost of Caesarean section	113.6
Labour of the farmer per hour	5.2
Price of a newborn male calf	619.7
Price of a newborn female calf	464.8
Cost of involuntary culling after first calving	348.1
Cost of involuntary culling after later calvings	549.5

A cost function for dystocia was derived both for male and female calves in first and later parities as:

$$C = [\Phi(t_2 - \mu) - \Phi(t_1 - \mu)]c_{diff} + [\Phi(t_3 - \mu) +$$

$$- \Phi(t_2 - \mu)]c_{caes} + [1 - \Phi(t_3 - \mu)]c_{foet} \quad (1)$$

where
$\Phi(t) =$ cumulative standard normal distribution;
$t_i - \mu =$ distance between mean liability and threshold t_i in units of the standard normal liability scale;
$c_{diff}, c_{caes}, c_{foet} =$ costs of difficult calving, Caesarean section and foetotomy expressed as extra costs with respect to normal calving;

$\Phi(t_i - \mu) - \Phi(t_{i-1} - \mu)$ gives the incidence of animals included in the i-1 category of calving score.
According to the methodology proposed by Meijering (1986), the economic value of calving performance was computed by partial differentiation of the cost function with respect to the population mean for the liability scale:

$$\delta C / \delta \mu = -c_{diff}\phi(t_1 - \mu) + (c_{diff} - c_{caes})\phi(t_2 - \mu) + \\ + (c_{caes} - c_{foet})\phi(t_3 - \mu) \qquad (2)$$

where $\phi(\mu)$ denotes the normal probability density function.

Economic values were then averaged over sex (ratio 50:50) within parity in order to get the final set of values for calving performance in heifers and in cows.

3. Results and discussion

Frequency distribution of calving score and stillbirth rates across parity and sex of the calf are given in Table 2. In first parity the incidence of Caesarean sections was 4 times greater in male than in female calves. Stillbirths rate in case difficult calvings was two times higher than in Caesarean sections apart from the sex of the calf. In later parities the percentage of Caesarean sections was reduced by over 30% in both sexes, while calving classified as difficult halved when female calves were born but just decreased of 25% in case of male calves. On average stillbirth rates lowered in adult cows compared to heifers, with the exception of female calves born with Caesarean sections. Unlike this study, Dekkers (1994) found in Holstein cows that the frequency of stillbirth was little affected by sex and parity in difficult and surgery classes.

Table 3 shows the total costs in Euros, expressed as a deviation from a normal calving, for difficult, Caesarean and foetotomy classes. Costs in foetotomy and Caesarean classes were much higher than costs in difficult calving category. Costs were dependent on the sex of the calf and parity of the dam.

Main cost components in the first parity were calf loss and veterinary fee. In heifers reduced fertility and increased culling had an impact in Caesarean or foetotomy categories only, while cost due to culling were higher in later parities, indicating that dystocia is an important reason to cull adult cows.

From the cost function (1) the costs of an average case of dystocia were estimated per sex and parity accounting for the incidence in the different classes of calving score.

In first parity costs were 61.8 Euro and 22.1 Euro for male and female calves respectively, whereas in later parities were 34.2 Euro and 11.4 Euro. The costs of dystocia was three times higher in male calves than in females calves both in first and subsequent parities. In adult cows costs halved compared to heifers due to the reduction in the incidence of dystocia, even though cost components increased.

Economic values, derived by partial differentiation of the cost function with respect to the mean of the normal underlying distribution and expressed for a 1% increase of dystocia, are in Table 3. In first parity the economic value was four times as high for male as for female calves, while in later parities was just two and a half times greater. Across parities a

higher difference in the economic value was found for male calves (three times more in first calving) compared to female calves. Averaging over sex (ratio 50:50) the economic value of calving performance was over two times greater in first than in later parities, in agreement with the results by Dekkers (1994).

Table 2. **Distribution of calving scores (%) and stillbirth rates percentages (in parentheses) per parity of dam and sex of calf.**

Calving score	First parity		Later parities	
	Males	Females	Males	Females
1 – Spontaneous	8.2 (8.3)	14.8 (3.4)	14.8 (4.7)	22.3 (2.0)
2 – Easy	55.1 (5.0)	65.7 (2.5)	66.5 (2.9)	68.7 (1.6)
3 – Difficult	15.2 (13.8)	13.6 (10.2)	11.5 (9.8)	7.2 (6.7)
4 - Caesarean section	20.8 (6.0)	5.5 (5.3)	6.9 (5.5)	1.6 (9.3)
5 – Foetotomy	0.7 (100)	0.4 (100)	0.3 (100)	0.2 (100)

Table 3. **Total costs as a deviation from easy calving per dystocia class, sex of the calf and parity of the dam, and economic values of calving performance per a 1% increase of dystocia in Euros.**

Calving score	First parity		Later parities	
	Males	Females	Males	Females
3 – Difficult	72.3	53.2	82.6	63.6
4 - Caesarean section	220.4	227.3	322.4	342.1
5 – Foetotomy	706.6	571.1	805.5	661.1
Economic value	-1.65	-0.39	-0.59	-0.25
	-1.02		-0.42	

4. Conclusions

The results of this study indicate that, for heavy muscled beef breed as Piemontese, calving performance is an economic important trait to include in the breeding goal.

Dystocia has a great economic incidence on the profit of the farms, especially when male calves are born from first parity cows. Calf loss is the most important cost in first calving, whereas in later parities also reduced fertility and increased culling rate are significant aspects.

The economic value of calving performance is considerably higher in first than in later parities, suggesting that calving performance in different parities should be treated as different traits not only from the genetic but also from the economic perspective.

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