

Cross Breeding in Dairy Cattle: The Effect on Calving Ease

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Summary

Calving traits for frequently used dairy breeds and crossbreeds were investigated using calving records collected in Australia over a period of 18 years. Dystocia (calving difficulty) was highest for heifers calving to Holstein-Friesian bulls, and Jersey calves caused the least dystocia. Incidence of dystocia in Holsteins was influenced by the season (gestation lengths were longer in winter, resulting in larger calves and more dystocia) and by the age of the cow, but these effects were less noticeable in Jersey cross calvings and there was no significant difference between calving months, sexes or cow ages for dystocia in Jersey calves. Logit transformation of proportion suffering dystocia reduced, but failed to eliminate, these significant breed interactions. Though there was a major breed difference for calving ease between Jersey and Holstein-Friesian bulls, the bull standard deviations of the two breeds for this trait were sufficiently large, relative to the breed differences, that there will be a small percentage of Holstein-Friesian bulls that may be as easy calving as many Jersey bulls.

Introduction

In Australia, dairy production has been mainly based on Holstein-Friesian cows, but some research has found that, from the perspective of production, survival and profitability, crossbreeding can be more profitable over three generations (Carrick *et al.*, 2003), with favourable outcomes associated with Holstein-Friesian crosses with Brown Swiss and Australian Red (a synthetic breed composed of Swedish and Danish Reds, Illawarra, Dairy Shorthorn) cows, compared with Holsteins. However this study did not include the differing effects of feed requirements, dystocia

or calf mortality within these breeds. Though Holsteins are the predominant dairy breed in Australia, many farmers currently choose to mate their Holstein-Friesian heifers to natural service Jersey bulls, in the belief that this will always lead to dystocia-free calving. As Jersey bulls are all assumed to be 'easy calving bulls,' no breeding values for dystocia are currently calculated or available for farmers to use.

Crossbreeding results in combinations of gene effects that are not usually found together in the purebreds and is generally reported as having positive outcomes. New combination of genes brought about by crossbreeding may enhance a trait, resulting in animals that may be bigger, better or more fitted to survival. However when applied to calving ease, bigger could mean more problems in the case of the calf. In the case of calving traits there are two aspects to be considered, the cow and her calf.

Interactions between effects (such as calf sex and age of dam) can lead to synergism. These types of interactions were convincing arguments for the use of threshold model techniques proposed by Gianola (1982), Gilmour (1983), and Harville (1984). These studies indicated that the discrete nature of the performance should be taken into account for the genetic evaluation by using a threshold model. Theoretically, linear models are not appropriate for categorical traits such as dystocia (Gianola & Foulley, 1983), though Misztal (1989) notes that threshold models can be up to five times more demanding of computer processing time. Groën (1998) recommended that threshold models be used for genetic evaluation of calving performance. A threshold model with herds as fixed effects can give numerical problems when all scores of a subclass fall in the same category (Harville & Mee, 1984), which can be avoided by deleting these classes or treating herds as

random (Berger, 1994). However, many consider that, even although a threshold model is theoretically the most correct method of evaluation, in practice there is little to be gained by its use. Djemali (1987) compared linear and threshold techniques for the analysis of data on calving difficulty. Although he found larger sire differences using the threshold model than were found using a linear model, the sire rankings had only minimal differences, although he cautioned that this might not be the case when the data was extremely unbalanced. Hoeschele (1988), using simulation, found that threshold models were only slightly advantageous when heritabilities were high, and that this advantage would be minimal for lower heritabilities. Analyses have shown that the sire solutions obtained by BLUP and non linear models are highly correlated (0.99) for dystocia and for stillbirth (Meijering & Postma, 1985; Weller *et al.*, 1988). If all animals are accurately evaluated (rather than, as is the case with dystocia in Australia, only some animals accurately evaluated in some herds) there is no clear advantage of using a threshold model instead of a linear model (Ramirez-Valverde *et al.*, 2001). Phocas (2003) concluded that although the best model from a theoretical point of view was a threshold model with a fixed herd year effect, from the practical point of view a linear model (also with herd as fixed effect) was the best choice for predicting calving difficulty with associated maternal

effects. As part of our investigations into calving difficulty, we applied both threshold and linear models to our datasets of various breeds and crossbreeds. This is a part of our work regarding dystocia.

Aim

To investigate the relative merits of linear and threshold models when analysing calving ease and to compare frequently used dairy breeds and the crossbred for incidence of dystocia in heifer calvings and interactions between fixed effects and breed.

Materials and Methods

A dataset of 1,243,580 calving records of dairy breeds and crosses was provided by the Australian Dairy Herd Improvement Scheme. It was edited to remove records with no breed or identification of sire or of dam, twins, induced calvings, father daughter matings, missing calving scores, or from herds that recorded all calvings as 'ok' or only difficult calvings in a season or that had fewer than four recorded calvings in a season. Univariate analyses (ASReml) of calvings of heifers, and all cow ages were carried out for the more commonly occurring breed combinations, using linear and threshold models, as below:

$$y_{ijklmp} \sim \mu + s_i + m_j + a_l + r_k + \sum(w_x \cdot y_z) + b_m + g_n + h_p$$

where

μ	denotes the population mean for the trait:
y_{ijklmp}	denotes presence or absence of dystocia where 0 = no dystocia and 1 = any calving difficulty
s_i	denotes the fixed effect of the i^{th} sex of the $ijklmn^{\text{th}}$ calf
m_j	denotes the fixed effect of the j^{th} month of birth of the $ijklmn^{\text{th}}$ calf
r_k	denotes the fixed effect of the k^{th} breed of the $ijklmn^{\text{th}}$ calf's breed ('SireDamBreed: see fig 1)
a_l	denotes the fixed effect of the l^{th} age (in six month steps) of the cow at calving
b_m	denotes the random effect of the m^{th} bull, the sire of the $ijklmn^{\text{th}}$ calf
g_n	denotes the random effect of the n^{th} bull, the maternal grandsire of the $ijklmn^{\text{th}}$ calf
interactions where $w_x \cdot y_z$ are:	
$s_i * m_j$	sex - month
$s_i * r_k$	sex - breed
$s_i * a_l$	sex - cow age
$m_j * r_k$	month - breed of sire and dam
$m_j * a_l$	month - cow age
$a_l * r_k$	age of cow – breed of cow
h_p	denotes the fixed effect of the p^{th} herd-year in which the $ijklmn^{\text{th}}$ calf was born.

Interactions whose adjusted F values were less than one were dropped from the model. Separate analysis was carried out for Holstein-

Friesians, Jerseys and Jersey-sire x Holstein-Friesian cross heifers.

Results

When separate analyses were performed for each breed, ease of Holstein-Friesian calvings

were significantly influenced by calf sex, cow age and month of calving. Jersey calvings were unaffected, and the Jersey-sired F1 cross was only influenced by the calf sex (Table 1).

Table 1. Adjusted *F* values for heifer Jersey, Holstein-Friesian and Jersey sired F1 cross calvings.

individual breed linear models				
	df	Jersey	Holstein	Jersey sired F1
sex	1	0.1	227.34	56.15
month of calving	10	1.09	5.08	1.38
cow age	2	0.82	4.47	1.27

Consequently, in the joint analyses of all breeds, calf sex and breed ('SireDamBreed') interacted with each other, and each also with

cow age for both linear and logit models (Table 2).

Table 2. Adjusted *F* values for linear and logit analyses (all common breed heifer calvings).

	df	linear	logit
* Sex	1	567.7	430.1
* SireDamBr	11	18.2	24.4
* CowAge	2	3.7	2.2
* Month	11	14.7	13.6
interactions:			
* Sex Sire-Dam Breed	11	11.8	2.8
* Sex Cow Age	2	8.3	5.7
Cow Age Sire-Dam Breed	22	2.0	1.8

Figure 1 shows the relative incidence of dystocia in the various breeds and crosses, and the influence of calf sex. Female calf incidence of dystocia in heifers was 29.2% (FFFFFFF), 9.4% (JJJJJJJ) and 12%

(JJJJFFFF). Male calves young heifer calvings and winter (August) all caused increased calving problems for Holstein-Friesian sired calves, but not for Jerseys.

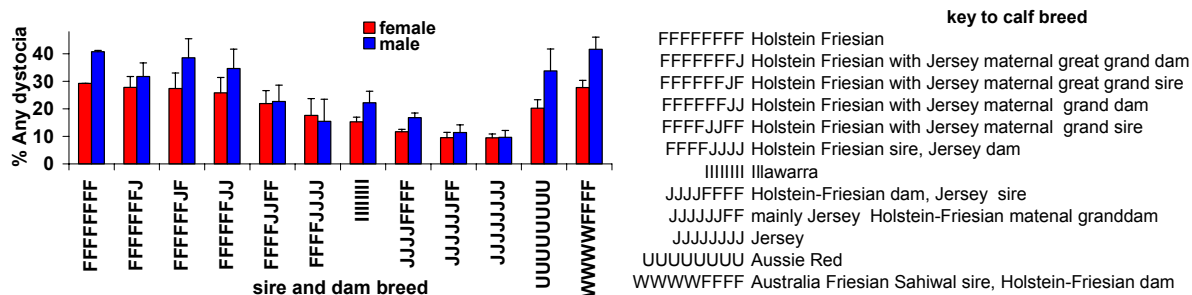


Figure 1. Heifer calvings: sex-breed interactions for dystocia (linear model).

Correlation between threshold and linear model Holstein-Friesian bull solutions was 0.981, and correlation between rankings was

0.978 for 3992 bulls, for all cow ages at calving.

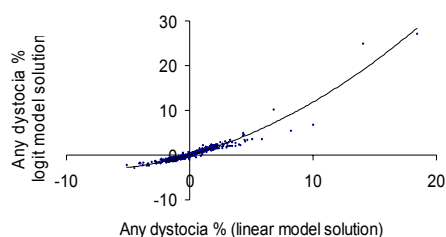


Figure 2. Comparison of Holstein-Friesian bull solutions from linear or threshold models (all).

Discussion

Unlike the Holsteins, incidence of dystocia in Jerseys appeared to be little affected by calving month, calf sex, dam age or maternal grandsire. The maternal grandsire of the most frequently found crossbreed (JJJJFFFF) had a greater influence on dystocia than the sire, and with reduced but still significant effects of calf sex. We had insufficient numbers of records for some breeds/crossbreeds to be significant. However the trends from the major breeds and crossbreeds analysis would suggest that calvings from part Jersey dams result in less dystocia, roughly in accordance with the proportion of Jersey in the calf. The deleterious effect of the male calf on dystocia decreases with increasing proportion of Jersey in the calf. Young Holstein-Friesian heifers are more susceptible to dystocia than older heifers. This may be due to a genetically based slower maturation rate for Holsteins, or may be due to the tendency of some farmers to raise their heifers with minimal or low quality feed. Although Holstein-Friesian bulls generally result in considerably more dystocia than Jersey bulls following matings to heifers, there appears to be small overlap of the bull solutions for the two populations. We have demonstrated that there are some Holstein-Friesian bulls that could produce the same incidences of dystocia in their progeny as some Jersey bulls.

It was hoped that the logit model would explain these synergistic effects without the need for interactions in the model. However, we found that this synergy was greater than the logit model predicted and therefore the interactions were usually still significant, though reduced, for our logit models compared with the linear models.

Conclusion

There appears to be little difference between bull rankings of Holstein-Friesian bulls estimated using threshold or linear models, even though the influences of the fixed effects differ markedly between the breeds and crossbreeds.

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