FINE CONTROL OF BULL ALLOCATION TO HELP AVOID DYSTOCIA

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SUMMARY

A method is presented for influencing mate selections according to phenotype. The example uses female body weight at or close to joining as an indicator of liability to dystocia in cattle. However, the method may also be applicable to sheep and other species. A common way to manage this issue is to allocate only good calving ease EBV bulls to heifers. However, the method presented here is more powerful, as it customises allocations according to the bodyweight of each female, with smaller heifers getting better calving ease bulls. In addition, the overall emphasis on calving ease can be controlled during a mate selection analysis, trading it off against all other issues.

INTRODUCTION

Breeders who want to manage calving ease in their herd (or flock) can choose bulls that have favourable EBVs for 'calving ease direct' (CED) – meaning that the genotype of the resulting calf is more favourable for calving ease at its own birth. A more refined solution is to use grouping to allocate only high CED bulls to heifers, as described in Figure 1.

However, the approach presented in this paper is more powerful than simple grouping, as it customises allocations according to the ***phenotype*** of each heifer for a liability indicator trait such as pre-joining bodyweight, with smaller heifers getting better CED bulls (Figure 1). In addition, when using a Mate Selection implementation (Kinghorn and Kinghorn 2019), the breeder can alter the overall emphasis on calving ease, trading it off against all other issues. This approach requires some upfront effort to define the parameters that reflect the breeder's desires in relation to calving ease for heifers of different weights, but it does allow for a more strategic use of sires.

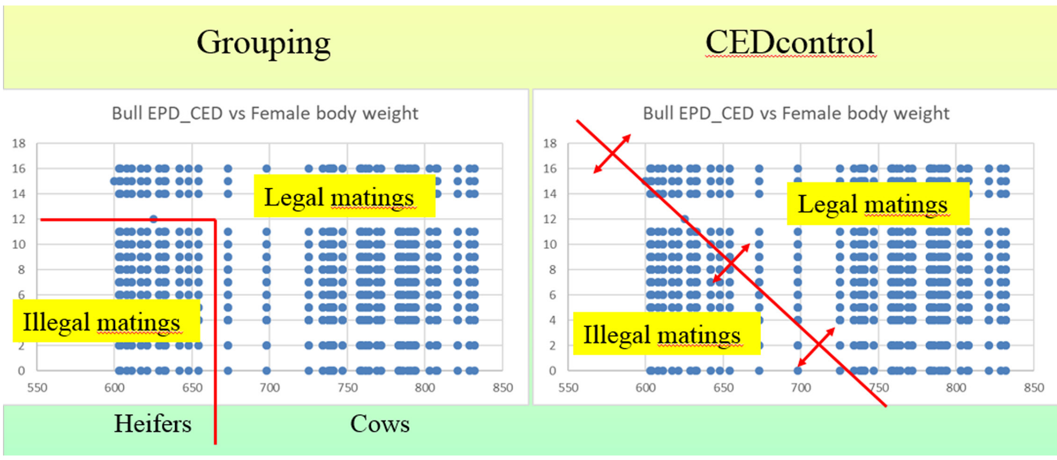

Figure 1. A contrast of simple grouping to allocate only high CED bulls to heifers (left pane), versus CEDcontrol which uses a sliding scale to prioritise the highest CED bulls to the females with the lowest body weight (right pane)

METHOD

A column in the data file with a descriptive header, e.g. "CEDcontrol" (calving ease control), or "BWTcontrol" (birthweight control), depending on what EBVs are available for ease of calving, has values entered as follows:

For each female candidate: Enter her current ***phenotype*** for body weight (or some such criterion of liability to calving difficulty).

For each male candidate: Enter -1 times the smallest weight of female that this bull should be allowed to mate, given its EBV for Calving Ease Direct (or some such EBV), according to the breeder's judgement.

With this setup, a mating between any bull and any cow gives a predicted progeny value for CEDcontrol that needs to be at least 0 to satisfy the breeder's desires in relation to calving ease for that female (see Table 1).

Table 1. Example calculation for male entries under data column CEDcontrol. Values for *Intercept* and *Slope* are calculated as shown below the table

Female body weight	Minimum Calving Ease Direct EBV chosen by breeder	Male entry for a bull of minimum EBV (*Intercept*+*Slope**EBV)	Predicted progeny value for CEDcontrol when using this bull
275Kg Heifer	+10	-400 + 12.5x10 = -275	0
300Kg Heifer	+8	-400 + 12.5x 8 = -300	0
400Kg Cow	0 (linear extrapolation)	-400 + 12.5x 0 = -400	0

Slope = $\frac{300-275}{10-8}$ = 12.5
Intercept = (2 x *Threshold*) -275 – (*Slope* x 10) = 0 -275 -125 = -400
Intercept = (2 x *Threshold*) -300 – (*Slope* x 8) = 0 -300 -100 = -400
… where *Threshold* = 0 in the example implementation (eg. last column, and in Figure 2).

The breeder only has to choose the four figures near the top left of Table 1: 275Kg, 300Kg, +10 and +8 (yellow shading). This represents the breeder's attitude to bull requirements for calving ease EBVs depending on female body weight. The third row (400Kg Cow) is only included for illustration. Notice that the fourth column (values = 0) is the average of the first and third columns, just as progeny predictions are the average of dam and sire EBVs.

Accordingly, what we enter for each bull in column CEDcontrol is *Intercept*+*Slope**CED where CED is the bull's Calving Ease Direct EBV. *Slope* and *Intercept* are calculated from the four figures chosen by the breeder, plus the target Progeny value threshold (*Thresh* = 0 here, but a different value can be chosen for cosmetic reasons).

The four driving figures (275Kg, 300Kg, +10 and +8 here) should cover the bodyweight region where calving ease is an issue. If there is little benefit from using high calving ease bulls over heavy cows, this is not critical, as the breeder can use a trait management tool in a way that gives no reward for high calving ease in heavy cows, eg. by only avoiding matings below the 0 threshold.

Once the CEDcontrol column has been made, the mate selection analysis is run with a constraint on progeny CEDcontrol to be at least 0 for all matings, eg. using 'Set minimum value at boundary' (see Kinghorn and Kinghorn 2019), as in Figure 2.

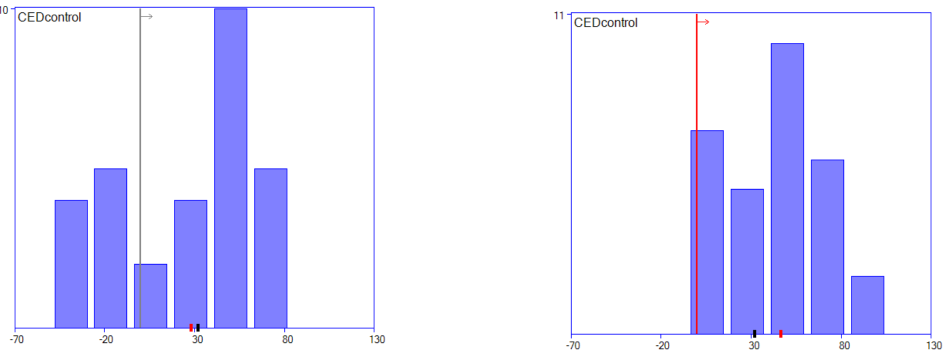

Figure 2. Setting CEDcontol boundary at zero to ensure that all matings conform to the breeder's calving ease policy with respect to female body weights. Left: Boundary not invoked (9 matings do not conform). Right: Boundary invoked (all matings conform). This is a small example with just 30 matings

RESULTS AND DISCUSSION

There are several main factors affecting calving difficulty including calf size, pelvic area of the cow, breed, parity of the calving, sex of the calf, gestation length, the season of the calving (Mekonnen and Moges 2016). Developing heifers on a low nutrient diet has clearly demonstrated an increase in dystocia. This is primarily due to poor skeletal growth and, therefore, smaller pelvic areas. While some studies have found that heifers of lighter weight have an increased risk of dystocia (Erb. *et al*. 1985; Naazie *et al*. 1989), other research has demonstrated that after calf size, the most important phenotypic predictor of dystocia is pre-calving pelvic area (Johnson *et al*. 1988). Heifers with a pelvic area of less than 140 cm^2 have increased incidence of dystocia compared to their above-average contemporaries. Larger heifers have larger pelvic areas, but they also have larger calves. Selecting large heifers for replacements may have little effect on dystocia unless pelvic areas are also known.

This paper has adopted female body weight as an indicator of liability to calving difficulties. Of course, the current method does not alleviate the situation by increasing the body weight of small heifers, but by aiming for them to have calves of smaller size, and/or whatever other attributes of calves lead to improved calving ease. This means that the observed impact of calf size on dystocia is also indicative of the value of the current method. It may be that some other trait or index of traits will be more diagnostic for the scenario in question than simple female body weight. The method proposed can use any such predictor.

High ewe liveweight and condition score during pregnancy may help indicate the risk of dystocia in sheep (Horton *et al*. 2017), such that the method proposed may be of some value in that species.

In a simple beef cattle example, a Trait Management tool (Kinghorn and Kinghorn 2019) was used to manage the progeny distribution of CEDcontrol, by setting a minimum boundary at 0 for predicted progeny merit, so that all matings satisfy the breeders desires (Figure 2).

The minimum boundary can be changed upwards from 0 to give even more overall emphasis on Calving Ease. This is a dynamic policy with smaller heifers always attracting more attention, whatever threshold is set. For example, to get 10 in the right-hand column of the top row of Table 1, still using the EBV = +10 bull, we would use a 295Kg heifer (as the average of 295 and -275 is 10). This means we would now afford a 295Kg heifer as much CED priority as we previously did for a 275Kg heifer. The breeder must then judge if the extra calving ease attained is worth the likely compromises seen in other issues, such as progeny merit for the selection index and inbreeding.

It is possible to scale this approach differently, so that a +1 progeny CEDcontrol value represents an increase of +1 in EBV units, setting the bar higher by that amount of EBV. Alternatively, if there is good predicted relationship between EBV and % calving difficulties, a breeder could operate directly at the level of predicted % calving difficulties.

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