Selection for a larger pelvic area to improve the proportion of natural calvings in beef cattle.

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Summary

In double muscled beef breeds like Belgian Blue and Improved Red Pied almost 90% of all calvings are performed by a cesarian section, to minimise the risk of stillborn calves. The high percentage of cesarian deliveries may raise consumer concerns about animal welfare. To improve the proportion of natural calvings, a breeding value estimation was set up to select for a minimum pelvic height of 20.5 cm for Belgian Blue and Improved Red Pied cattle. From 2008 pelvic measurements were performed with the Rice pelvimeter on Belgian Blue and Improved Red Pied cattle. Measurements were performed between the age of 18 months and 6 years, when final pelvic size was reached. Genetic parameters for pelvic height and width were estimated. Heritabilities for pelvic height and width in Improved Red Pied cows were respectively 0.30 and 0.35, for Belgian Blue the heritabilities were 0.23 for both traits. Repeatabilities were 0.55 and 0.56 for height and width in Improved Red Pied. Breeding values of cows are sent to the participating farmers and the Belgian Blue and Improved Red Pied herdbooks receive breeding values of their sires.

Keywords: pelvic measurements, natural calving, beef cattle, genetic parameters, breeding value

Introduction

Calving difficulty is becoming a large problem for beef breeds, especially the double muscled breeds. Cows with a pelvic height of less than 20.5 cm are not able to calve naturally and a cesarian section is necessary (Ten Napel, 2011). However, cesarian sections have a negative effect on the health of a cow and they will limit the productive life of a cow (Deutscher, 2012).

To increase the percentage of natural calvings for beef breeds, a breeding value estimation was developed for pelvic size. Dimensions of the pelvic area are weakly related to exterior conformation traits of beef cattle (Deutscher, 2012; Veulemans, 2017). Only stature may have a significant correlation with pelvic size, but larger cows will also have proportionately heavier calves, which minimizes the effect on calving ease. Therefore, to increase pelvic dimensions pelvic height and width were included as selection traits.

Data were collected from 2008 by using the Rice pelvimeter (Kolkman et al., 2009; Kolkman et al., 2012). After the first estimation of genetic parameters in 2012, in 2015 genetic parameters for pelvic height and width were estimated in a larger data set of Belgian-Blue and Improved Red Pied cows, within and across breeds (De Haer, 2015).

Material and methods

Pelvic height and width were measured at herdbook-registered animals from an age of 18 months. Measurements were preferably yearly repeated till an age of 6 years. It is assumed that the
pelvis is full grown from 6 years of age. Data of female animals with at least 50% of Belgian Blue or Improved Red Pied breed were used to estimate genetic parameters. The Rice pelvimeter can measure a range of 8 to 21 cm. (Kolkman et al., 2009; Kolkman et al., 2012). When the pelvis measurement was recorded as 22 cm or more (indicating higher or wider than 21 cm), the score was set to 22. Values of less than 8 cm and were set to missing.

The data set consisted of 2822 records of 2137 cows on 105 herds, collected from 2006 to 2015. For Belgian Blue, 140 of 1244 cows had repeated records (2, 3 or 4), for Improved Red Pied 338 of 893 cows had repeated records (2, 3, 4, or 5). Minimum height and width were 11 cm and 8 cm, maximum height and width were 22 and 21 cm.

Genetic parameters were estimated with the following models (ASReml (Gilmour et al., 2006):

\[
\text{Within breed:} \\
Y_{ijkl} = \mu + Hys_i + \text{Age}_j + \text{Dac}_k + \text{Perm}_l + \text{Ani}_o + e_{ijkl}
\]

\[
\text{Across breeds:} \\
Y_{ijklmn} = \mu + Hys_i + \text{Age}_j + \text{Dac}_k + \text{Perm}_l + \text{Breed}_m + \text{Ani}_o + e_{ijklmn}
\]

Where:
- \(Y_{ijklmn}\) : measurement of pelvic height or width in cm x 10
- \(\mu\) : average value
- \(Hys_i\) : fixed effect of herd * measurement date
- \(\text{Age}_j\) : covariable age at measurement (periods of half a year)
- \(\text{Dac}_k\) : covariable days after calving (max 300)
- \(\text{Perm}_l\) : random permanent environment effect
- \(\text{Breed}_m\) : fixed breed effect (IRP or BB)
- \(\text{Ani}_o\) : random genetic effect of animal
- \(e_{ijklmn}\) : random error

Results

Means for pelvic height, across and within breeds, are presented in Table 1. Differences in height and width between breeds were small.

Table 1. Averages and standard deviations for pelvic height and width (cm x 10) within and across sex and breeds.

<table>
<thead>
<tr>
<th>breed</th>
<th>#obs</th>
<th>height mean</th>
<th>height st.dev.</th>
<th>width mean</th>
<th>width st.dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRP</td>
<td>1391</td>
<td>184.2</td>
<td>18.0</td>
<td>152.5</td>
<td>18.5</td>
</tr>
<tr>
<td>BB</td>
<td>1431</td>
<td>180.5</td>
<td>24.4</td>
<td>147.1</td>
<td>25.3</td>
</tr>
<tr>
<td>Across breeds</td>
<td>2822</td>
<td>182.3</td>
<td>21.5</td>
<td>149.8</td>
<td>22.4</td>
</tr>
</tbody>
</table>

In Figure 1 the pelvic height and width per year are shown, for Improved Red Pied and Belgian Blue cows. With increasing age there was a gradual increase in size, but from an age of 6 years the growth will stop. There was no significant effect of breed on pelvic dimensions.

In Figure 2 the height and width are shown by increasing number of days after calving, for Improved Red Pied and Belgian Blue cows. During the first 10 days after calving there was a small decreasing effect on pelvic height and width, but after this interval there was no significant trend.
Table 2. Genetic, permanent environment, error and phenotypic standard deviations across breeds (overall) and within breeds (IRP and BB) for height and width (×10 cm).

<table>
<thead>
<tr>
<th>trait</th>
<th>breed</th>
<th>gen.st.dev.</th>
<th>perm.st.dev.</th>
<th>err.st.dev.</th>
<th>phen.st.dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>height</td>
<td>overall</td>
<td>8.22</td>
<td>8.02</td>
<td>9.60</td>
<td>14.97</td>
</tr>
<tr>
<td></td>
<td>IRP</td>
<td>7.43</td>
<td>6.72</td>
<td>9.10</td>
<td>13.54</td>
</tr>
<tr>
<td></td>
<td>BB</td>
<td>8.00</td>
<td>14.69</td>
<td>16.73</td>
<td></td>
</tr>
<tr>
<td>width</td>
<td>overall</td>
<td>9.41</td>
<td>7.66</td>
<td>9.69</td>
<td>15.53</td>
</tr>
<tr>
<td></td>
<td>IRP</td>
<td>8.24</td>
<td>6.28</td>
<td>9.24</td>
<td>13.89</td>
</tr>
<tr>
<td></td>
<td>BB</td>
<td>8.38</td>
<td>15.27</td>
<td>17.42</td>
<td></td>
</tr>
</tbody>
</table>

Heritabilities across breeds are 0.30 for height and 0.37 for width (Table 3). Within breeds, heritabilities are lower. The lower heritabilities for BB were due to a larger error standard deviation within BB (Table 2). For BB no repeatabilities could be estimated, as there were no repeated records. Repeatabilities for IRP are 0.55 and 0.56 for height and width (Table 4). Genetic correlations between pelvic height and width are low, therefore, width and height should be considered as different traits. However, including both traits in a multi-trait breeding value estimation will increase reliabilities compared to a single-trait breeding value estimation.

Table 3. Heritabilities, repeatabilities for pelvic height and width and genetic correlations between pelvic traits across breeds (overall) and within breeds. Standard errors are in italics.

<table>
<thead>
<tr>
<th>breed</th>
<th>trait</th>
<th>heritabilities</th>
<th>repeatabilities</th>
<th>genetic correlation with width</th>
</tr>
</thead>
<tbody>
<tr>
<td>overall</td>
<td>height</td>
<td>0.302</td>
<td>0.054</td>
<td>0.589</td>
</tr>
<tr>
<td></td>
<td>width</td>
<td>0.367</td>
<td>0.053</td>
<td>0.610</td>
</tr>
<tr>
<td>IRP</td>
<td>height</td>
<td>0.302</td>
<td>0.076</td>
<td>0.548</td>
</tr>
<tr>
<td></td>
<td>width</td>
<td>0.352</td>
<td>0.073</td>
<td>0.557</td>
</tr>
<tr>
<td>BB</td>
<td>height</td>
<td>0.229</td>
<td>0.056</td>
<td></td>
</tr>
<tr>
<td></td>
<td>width</td>
<td>0.231</td>
<td>0.054</td>
<td></td>
</tr>
</tbody>
</table>

Discussion and conclusions

Heritabilities and genetic variation of pelvic height and width show possibilities for selection for larger pelvic dimensions. As the pelvis is growing till an age of about 6 years, repeated measures will give a better indication of the adult pelvic size of an animal. Days after calving show no significant effect on height or width.

Selection for larger pelvic dimensions may lead to increased calf size and therefore, a negative correlation between maternal and direct calving ease (Vanderick et al., 2017). In the current data set only 10% of the calvings was not cesarian, so no correlations could be estimated between pelvic size and calving ease or between maternal and direct calving ease. But if birth weight of the calf is accounted for, selection for increased dimensions of the cow can be realized without large increases in calf size (Morrison et al., 1986). This can be realized by selecting sires with favorable breeding values on (low) birth weight and (high) growth rate at young age.

Mean height and width of female animals show that an increase of at least 2 centimeters is necessary for pelvic height to reach the threshold of 20.5 cm, necessary for natural calvings.
Implications

In the most recent breeding value estimation (June 2017) for Improved Red Pied and Belgian Blue cattle, 6274 records of 4688 animals were present, divided over 222 herds.

Reports per herd, including measurements and breeding values of cows are sent to the participating farmers. The Belgian Blue and Improved Red Pied herdbooks receive breeding values of their sires ready for publication.

Acknowledgement

The analysis was made possible by the LTO Noord project ‘Bewust Natuurlijk Luxe’, which provided the data. Also Iris Kolkman is gratefully acknowledged for developing the method to measure the pelvic dimensions.

List of references


Veulemans, W., 2017. Correlations between breeding values of Belgian Blue cattle. Personal Communication, CRV.
Figure 1. Average pelvic height and width in cm per year, for Improved red Pied and Belgian Blue cows.

Figure 2. Average pelvic height and width in cm by days after calving, for Improved red Pied and Belgian Blue cows.