IMPROVING CARCASS TRAITS IN CROSSBRED DAM LINE LAMBS THROUGH SELECTION OF THE CROSSING SIRES

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INTRODUCTION

In many countries sheep production is based on crossing specialised sire and dam breeds. While the use of complementary breeds is biologically efficient overall (Smith, 1964), a by-product is produced in the form of F₁ male lambs of the dam line, unnecessary for breeding. In the UK, a stratified crossbreeding system exists that integrates different systems of sheep production (with their specific breed types) which have been developed to suit different climatic and topographical circumstances. Most commercial females are F₁ crosses between ‘Longwool’ crossing sire breeds and ewes of hill breeds. Improving the carcass quality of their male sibs would give a valuable boost to the economics of the system. In 1999, only 47% of all carcasses in the UK met the target specifications for weight, fat and conformation (MLC, 2000). Better and more consistent quality is becoming an increasingly important issue within the meat sector. Genetic improvement for meat traits in crossing sire breeds would improve the quality of crossbred wethers and gains would also filter through to the terminal sire cross lambs produced by the crossbred ewes. It is therefore worth exploring the economically optimal selection objectives for crossing sire breeds, including meat production of crossbred males, whilst not compromising their value as sires of F₁ ewes of superior reproductive competency. This paper investigates the association between traits measured on 21-week old lambs of a crossing sire breed (here the Bluefaced Leicester) and a number of traits measured on the carcasses of their crossbred wether offspring.

MATERIAL AND METHODS

Purebred crossing sire resource. Bluefaced Leicester (BFL) crossing sires were selected from around 800 ram lambs born in each of 1997, 1998 and 1999 in the 13 flocks of the Penglas BFL Group Breeding Scheme. Data were also available on 2000-born lambs, when a 14th flock had joined the Scheme. Flocks were located in Wales, Scotland and England and managed under diverse conditions. They were genetically linked by use of some sires in common through AI. At approximately 21 weeks of age, all lambs were weighed, ultrasonically scanned for muscle and back fat depth at the third lumbar vertebra and assessed for gigot conformation on a scale from 1 (poor) to 6 (excellent). A total of 3075 valid records were used from animals between 90 and 182 days of age at scanning (excluding castrates and artificially reared lambs). The rams for crossing were selected to represent the full spectrum of index and conformation scores by applying an elliptical design (Cameron and Thompson,
1986) with regard to their (unscaled) lean index score and their residual (live) gigot conformation score after correction for fixed effects (year, flock, sex, age at measurement and age of rearing dam). The lean index included 21-week live weight and ultrasonic muscle and fat depth and was designed to increase carcass lean and reduce carcass fat weight without changing live weight. The ellipse value was chosen such that a predetermined proportion of the individuals was outside the ellipse and hence chosen as potential crossing sires.

Production of crossbred lambs. In each of three years (1998 to 2000), 1,500 hill ewes (equal numbers of Scottish Blackface and Hardy Speckled Face) were mated to 15 BFL rams. Ewes were divided over three farms balanced by breed, source, age and condition score and allocated to mating groups balanced by numbers at each site, age and condition score. Out of 4,538 inseminations, 3,334 resulted in a litter of crossbred ‘Mule’ (BFL x hill breed) lambs. In total, 5,537 Mule lambs were born of which 4,846 were weaned. The male lambs were castrated at birth and slaughtered once they had reached a degree of ‘finish’ equivalent to the borderline between fat class 2 and 3L. The age at which ‘finished’ condition was reached varied widely between 74 and 300 days. Over the three years, 2,255 wether lambs were slaughtered, of which 2,192 had complete records that were used for analysis.

Performance recording on Mule lambs. Lamb data included birth and rearing type, (foster) dam identification, birth date, sex, weight at birth, 5, 10 and 16 weeks of age and at finished condition. ‘Empty’ body weight of wether lambs was measured after being off food overnight. In the abattoir, carcasses were weighed and graded for fatness (using the ‘standard’ MLC 7-point scale and an assessment of the subcutaneous fat percentage) and conformation (using the EUROP scale, and a 15-point scale for the shoulder, loin, gigot and the carcass overall). Cold carcass weights were recorded after chilling overnight. In total, 794 carcasses were dissected; 20% had a full side dissection and 80% had a shoulder dissection only. This percentage was determined by the double sampling technique described by Conniffe and Moran (1972). A large number of measurements was taken on dissected carcasses including the eye muscle area at the third lumbar and 12th rib position. Carcasses undergoing full side dissection were separated into eight joints (leg, chump, loin, breast, best end neck, middle neck, shoulder and scrag) as described by Cuthbertson et al. (1972). Joints were dissected into lean, intermuscular and/or subcutaneous fat, vertebral processes (if applicable) and other bone, and waste.

Statistical analyses. Heritabilities and genetic and phenotypic correlations were calculated for the purebred BFL fitting a multi-variate Animal Model to the four traits measured at 21 weeks: live weight (SLW), ultrasonic fat (UFD) and muscle depth (UMD) and gigot conformation (CONF). Fixed effects included a combined flock-year-sex effect, a combination of birth and rearing type (6 classes), age of rearing dam (1 or 2, 3, 4 to 6 or more than 6 years old) and age at scanning (in days) as a covariate.

The finish and slaughter traits on the crossbred Mule wethers were analysed using a regression model. Results are shown for live weight at finished condition (FINWT), age at slaughter (SLAGE), overall carcass conformation on a 15-point scale (C15ALL), assessed percentage of subcutaneous fat (FATPC), cold carcass weight (COLDWT) and on dissected carcasses the eye muscle area at the third lumbar position (EYELUM), percentage of lean and fat in the
shoulder joint (SHL_LN and SHL_FAT) and percentage of lean and fat in all eight joints together (TOT_LN and TOT_FAT). For part-dissected carcasses the latter values were estimated by using the regression of TOT_LN on SHL_LN (and similarly for TOT_FAT on SHL_FAT) obtained from fully dissected carcasses and scaling the predicted values to the same mean and standard deviation as the directly observed values. In the regression model, true and predicted values were then weighted by the accuracy (unity for observed values and equal to the correlation coefficient between shoulder and all joints in fully dissected carcasses). Fixed effects in the regression model included year, site and their interaction, dam breed, birth-rearing type, age of the (rearing) dam (both classified as in the purebred data) and condition score at finish as a covariate, to adjust for (small) differences in degree of finish. The variables were regressed on lean index and on residual conformation score of the sire. Subsequently, purebred and crossbred data were combined and genetic correlations were calculated between the four live measurements on the BFL lambs at a fixed age of 21 weeks and the live and carcass measurements on crossbred ‘Mule’ wethers at a fixed degree of finish. To obtain genetic correlations, all trait combinations were fitted in combination with SLAGE in a multi-variate model with fixed effects identical to these described above for each dataset (the fixed-effect model for SLAGE was identical to this for the other Mule traits). A random animal effect was included fitting the genetic relationships between all animals involved.

RESULTS AND DISCUSSION
The heritabilities for the traits measured on the purebreds were moderate (0.26 ± 0.03 for SLW, 0.30 ± 0.03 for UMD, 0.34 ± 0.03 for UFD and 0.18 ± 0.03 for CONF), which is slightly lower for SLW and UFD than reported previously for this breed (Van Heelsum et al., 2001). The genetic correlations were somewhat higher than reported before with values between 0.63 and 0.72. These values offer considerable scope for genetic improvement, but when combining the traits in a selection index the positive correlations could cause progress made in muscle depth to result in an undesirable increase in fat depth and size. The lean index value of the purebred sire (based on objective measurements of live weight, fat and muscle depth) had a small positive effect on FINWT and EYELUM and a negative effect on FATPC (P < 0.05) but no effect on COLDWT, C15ALL or SLAGE (P > 0.05). The regression was highly significant (P < 0.001) for SHL_LN and TOT_LN (positive) and SHL_FAT and TOT_FAT (negative). This suggests that offspring of high-index rams put on more muscle and less fat in virtually the same time as low-index offspring, without a large increase in size or change in conformation. The residual conformation score of the sire had a negative effect on FINWT, FINAGE (P < 0.001) and COLDWT (P < 0.05) but not on any of the other finish or slaughter traits (including the conformation assessments), suggesting that offspring of high-conformation sires reached finished condition more quickly and at a lower weight than offspring of low-conformation sires.

Table 1 shows the genetic correlations between traits measured on the purebreds at 21 weeks of age and the finish and slaughter traits measured on the crossbreds at equal level of finish. Correlations with TOT_LN and TOT_FAT are not shown because the parameter estimates did not converge. Many standard errors were large, but in general the ultrasonic measurements on the purebreds correlate favourably with lean and fat in the carcass of crossbreds, confirming
the regression results. Offspring of high conformation sires again reached finished condition at a smaller size, but here a positive correlation with carcass conformation was found.

Table 1. Genetic correlations (± s.e.) between purebred and crossbred performance fitting each trait combination in a multi-variate model also including age at slaughter

<table>
<thead>
<tr>
<th>Purebred traits</th>
<th>FINWT</th>
<th>COLDWT</th>
<th>FATPC</th>
<th>C15ALL</th>
<th>EYELUM</th>
<th>SHL_LN</th>
<th>SHL_FAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLW</td>
<td>-0.36±0.27</td>
<td>-0.40±0.31</td>
<td>-0.56±0.34</td>
<td>0.16±0.26</td>
<td>0.34±0.22</td>
<td>0.02±0.18</td>
<td>-0.09±0.19</td>
</tr>
<tr>
<td>UMD</td>
<td>-0.07±0.20</td>
<td>-0.08±0.21</td>
<td>-0.65±0.34</td>
<td>0.21±0.21</td>
<td>0.58±0.17</td>
<td>0.34±0.10</td>
<td>-0.50±0.20</td>
</tr>
<tr>
<td>UFD</td>
<td>-0.42±0.13</td>
<td>-0.38±0.12</td>
<td>0.27±0.22</td>
<td>-0.05±0.16</td>
<td>-0.10±0.11</td>
<td>-0.46±0.11</td>
<td>0.45±0.11</td>
</tr>
<tr>
<td>CONF</td>
<td>-0.53±0.19</td>
<td>-0.32±0.21</td>
<td>-0.25±0.27</td>
<td>0.45±0.23</td>
<td>0.02±0.23</td>
<td>-0.04±0.18</td>
<td>0.02±0.10</td>
</tr>
</tbody>
</table>

CONCLUSION
Results clearly show that there is considerable scope for improvement of lean and fat content in the carcasses of crossbred offspring by using ultrasonic measurements on the purebred generation in a suitable selection index that does not need to lead to a large increase in size or decrease in conformation. The benefit of selection on live conformation remains unclear.

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REFERENCES