Name: Huw Jones

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Abstract:

The price obtained for lamb carcass has a direct effect on the profitability of a sheep system and hence market requirements should be directly reflected in the objective of any breeding program for sheep. Despite their importance, market requirements are often assumed rather than known and market prices are not always used to form the objective. Moreover, although carcass shape affects commercial value, it has not been directly considered in current breeding programs. The aims of this study were (i) to develop methods of incorporating measures of carcass shape into selection programs (ii) to establish the requirements of the current and likely future markets for lamb and (iii) to develop methods for calculating economic values for selection objectives.

Carcass shape is quantified commercially using a conformation score. However, the assessment is subjective and confounded with fatness and hence an objective assessment of muscularity is undoubtedly preferable. Five measures of muscularity (three for the *M. longissimus thoracis et lumborum* (LTL) muscle, one for the hind leg and one for the whole carcass) were derived from carcass dissection data for 100 Suffolk, 40 Texel and 20 Charollais lambs. Changes with growth, relationships with tissue composition and lean distribution, as well as the relationships between the different muscularity measures were investigated. Higher muscularity at a given live weight was generally associated with higher lean to bone ratio and carcass lean content. Associations with fat content were either non-significant or negative. Relationships with lean distribution were also non-significant. Correlations between muscularity measures in different regions were low in Suffolk and Charollais lambs but higher for the Texels. This suggested that more than one measure would be required, particularly for Suffolk and Charollais lambs, if the muscularity of a carcass was to be described effectively.

The feasibility of developing live animal measurements of muscularity using measurements taken on X-ray Computer Tomography (CT) scans was investigated using data collected on the lambs described above. Measurements for the LTL and the whole carcass were obtained using measurements of components similar to those used to derive the carcass measures. For the hind leg, indirect measures were developed using the ratio of two measurements taken on scans through the hind leg. Correlations between the carcass and corresponding CT measure ranged from around 0.6 for the hind leg and the whole carcass measure to around 0.35 for the LTL measures. The results indicated that the CT measures of muscularity derived provided good *in vivo* predictors of muscularity in the hind leg and through the whole carcass, but were comparatively less useful for predicting carcass LTL muscularity.

Genetic parameters for each of the CT measures of muscularity were estimated using data for approximately 950 lambs from each of the three breeds. Heritability estimates for each of the CT
measures of muscularity were moderate to high (0.21-0.57) and coefficients of variation were in the range of 5-10%. Genetic correlations with lean weight, fat weight, scan live weight and ultrasound measured fat depth were generally not significantly different from zero in each breed. Genetic correlations with ultrasound measured muscle depth were positive. Given these parameters, improvement in muscularity at an age could be achieved through selection, whilst continuing to increase the weight of lean and reduce the weight of fat. The latter are common goals for many current selection programs.

A case study was conducted to establish current and likely future markets for lamb. Questionnaires were sent to the largest lamb retailers and abattoirs in the UK. Current markets generally required a carcass weight 16-21kg, conformation E-R and fat score 2 or 3L. The forecast for future requirements was not clear, although both abattoirs and retailers desired carcasses that fitted a narrower range of quality specifications and foresaw increasing demand for heavier carcasses (above 21kg) to supply bone-less products. This suggests that a two-market scenario, one for medium sized lambs to supply bone-in cuts, and the other for heavier, lean carcasses to supply bone-less lamb, could develop in the long term.

A bio-economic model was developed to calculate the economic value of one unit increase in the weight of lean and fat at 150 days of age. The model was designed to account for (i) seasonal fluctuations in market prices, (ii) different drafting criteria, (iii) feed requirements of individual lambs and (iv) seasonal variation in feed costs. Data collected on Suffolk cross mule, castrated male and female lambs (collected in a separate trial) was used to adapt the model to represent likely commercial conditions. The commercial value of carcasses of varying quality at different times of the year were derived using the price grid obtained from the questionnaire study (Chapter 5), and historical national weekly average prices from 1995 to 2000. The economic values varied depending on which year was used to provide market prices. Across-sex economic values for lean weight ranged from 1.10 to 1.90 £/kg and for fat from -1.93 to 0.13 £/kg. These values are specific to the scenario considered, however the model could also be adapted to obtain values for a range of other conditions.

The results presented in this thesis do not provide all the information required to develop the most suitable selection indices for use in terminal sire breeds in the UK. For example, uncertainty still exists over the requirements of future markets for lambs. Nevertheless sufficient information is provided to allow the development of a range of possible selection indices that include measures of carcass shape amongst the selection objectives. Once developed these indices could be presented representatives from different sectors of industry and decisions made, regarding the most appropriate indices to use, following discussions with them. The results of the case study presented in this thesis would also provide a very useful base from which to develop these discussions.

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