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Discriminating among animals for improved rewards from traditional meat cuts

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ABSTRACT

The influence of biological variation on animal numbers meeting specifications based on alternative indicators of carcass merit to GR and carcass weight (CW), and the value of live animal indicators in meeting particular goals were investigated. Percentages of carcasses achieving a two-trait (GR: 5.5 to 9.5mm; and CW: 15.5 to 17.5kg) and a three-trait (GR, CW and various leg lengths: T) specification were analytically derived over multivariate normal distributions. Two 'populations' of sheep were considered; one with a mean CW, GR and T of 14.6kg, 6.8mm and 184mm, respectively, and the second with mean values of 15.5kg, 6.8mm and 186mm. Adding conformational traits reduced the proportion achieving the specification, with the reduction being greater if the correlations between traits were antagonistic. Analysis of potential carcass merit indicators from experimental dissection data indicated that 8% of the variation in leg weight was associated with sire breed, sire, sex and birth rank effects, while 32% was associated with animal variations in six linear indicators (high GR, low subcutaneous leg fat depth, high carcass length, T, high proximal leg circumference, and low total length of the leg joint). Together these two classes of indicators accounted for 36% of the total variation among lambs.

Keywords: Sheep; carcass classification; specification; conformation; predictors.

INTRODUCTION

A number of New Zealand meat processors have recently considered using measurements in addition to carcass weight (CW) and GR for grading in order to procure carcasses better suited to the high value chilled cut trade, with most focusing on aspects of hindleg conformation. The New Zealand export lamb carcass grading system financially rewards for lean and penalises for fat (Waldron *et al.*, 1991). Relative economic values (REVs) for lean and fat calculated elsewhere indicate similar emphasis in other countries (Simm and Dingwall, 1989). However, imprecision in a grading system based on CW and GR is such that significant variation is found in the weight of lean and fat between carcasses within a grade (Kirton *et al.*, 1985). As a classification system becomes more complex by measuring more traits to improve prediction, the processors 'hit-rate' (percentage of animals achieving the specification) and the ability to select appropriate animals on-farm become increasingly important. This paper examines the effects of using a more complex classification system, firstly by estimating the reduction in 'hit-rate' of a characterised group of animals achieving a carcass specification when aspects of hindleg conformation are added to the current CW and GR based system. Secondly, the theoretical scope for developing on-farm indicators to predict animals meeting specifications of this type is examined in order to determine if 'hit-rate' could be improved through selection of better animals on-farm.

MATERIALS AND METHODS

Hit rates

Percentages of carcasses achieving a given specification were calculated by numerically integrating over multivariate normal distributions with means and phenotypic SD's as specified in Table 1, and correlations between traits as specified in Table 2. A full description of carcass traits used in this analysis and their abbreviations are given in Table 1. These parameters came from experimental dissection data involving 1602 Romney and Romney-cross progeny from 102 sires including the Romney, Border Leicester, Poll Dorset or Coopworth breeds (Waldron *et al.*, 1992), and the traits were assumed to be normally distributed. Two theoretical 'populations' of animals were tested. 'Model 1' (Table 1) used the means and phenotypic standard deviations directly from Waldron *et al.,* (1992). 'Model 2' increased the mean values for CW and hindleg length (T) to means of 15.5 kg and 186mm, respectively, which were considered to be more representative of the New Zealand sheep industry. Standard deviations for CW and T were adjusted to keep the coefficients of variation the same as those in Waldron *et al.,* (1992). A two- and a three-trait specification were set to determine expected 'hit rates' (proportion of carcasses meeting the specification) from the two populations. The two-trait specification was based on carcasses being inside a 15.5 – 17.5kg and 5.5 – 9.5mm range for CW and GR, respectively. The three-trait specification included a measurement of T in addition to CW and GR, with the aim of rewarding producers for animals with a given hindleg conformation. Short, medium and long T specifications were tested, with specification boundaries set at 164 – 184, 174 – 194, and 184 – 204mm, respectively.

Alternative indicators

The value of on-farm factors and alternative linear carcass dimensions for predicting carcasses likely to meet a specification based on the relative size of the leg were examined using multiple regression analysis. Linear indicator traits included all those studied by Waldron *et al.,* (1992), with emphasis on the dimensional traits listed in

TABLE 1: Carcass trait definitions, and phenotypic means and standard deviation for the two simulation models tested

Trait	Description	Model 1 Mean	Model 1 SD	Model 2 Mean	Model 2 SD
CW	Hot carcass weight (kg)	14.6	1.89	15.5	2.00
GR	Tissue thickness 11 cm from midline at the 12th rib (mm)	6.8	2.40	6.8	2.40
L3	Deepest fat depth at the gluteus medius on the surface of the leg where it is removed from the loin (mm)	4.1	2.22		
CL	Carcass length from the bottom of the gambrel in the hind leg to the base of the neck (mm)	951	34		
T	Length from the distal anterior edge of the central and fourth tarsals to the proximal edge of the tibial tuberosity (mm)	184	8	186	8.1
CIR	Horizontal circumference of the carcass at the level of the tailhead (mm)	594	25		
LL	Length of the leg from the cut surface of the leg to the distal anterior edge to the central and fourth tarsal bones (mm)	405	74		

TABLE 2: Phenotypic correlations* between hot carcass weight, GR and leg length

	CarcassWeight	GR	Leg length
Carcass Weight	1	0.67	0.55
GR		1	0.30
Leg Length			1

*from Waldron *et al.* (1992)

Table 1 (GR, L3, CL, T, CIR and LL). The analyses also included identifiable on-farm effects associated with age at slaughter, breed of sire, sire within breed of sire (as a random effect), sex of lamb (ewe or wether) and birth rank (single or multiple). Prior to these analyses, between-animal variations in leg weight were adjusted for variations in year, rearing group and slaughter group effects to provide data more closely reflecting commercial lamb drafts. Leg weight was then adjusted for variations in loin weight to reflect variations in the weight of the leg that would not require a sacrifice in the yield of meat from the valuable loin region of the carcass.

RESULTS

Hit rates

Using the specification based on CW and GR alone, the overall mean values of 17.3 and 24.7% of carcasses met the specification (Table 3) for Models 1 and 2, respectively. Both models revealed the same trends for the three-trait specification in that adding a third trait reduced the hit rate in all cases. Maximum hit rates were achieved when the middle of the T specification was set to the population mean (14.0 and 19.9% for Models 1 and 2, respectively). The proportion of animals meeting the three-trait specification diminished as the mid-point of the specification moved either side of the mean, and the reduction in hit rate was greater for the short-T rather than the long-T specification.

TABLE 3: Percentage of carcasses achieving specification for a two-trait (CW and GR) and a three-trait classification (CW, GR and T)

	Model 1 (14.6 ± 1.89 kg CW)		Model 2 (15.5 ± 2.00 kg CW)	
	2 trait	3 trait	2 trait	3 trait
	17.3		24.7	
Short T (164 - 184mm)		4.7		6.9
Medium T (174 - 194)		14.0		19.9
Long T (184 - 204)		12.5		17.6

Alternative indicators

Adjustment for between-animal variations associated with year and slaughter group reduced the standard deviation in leg weight from 674g to a residual standard deviation (rsd) of 374g ($r^2 = 0.79$). On-farm effects associated with sire breed, sire, sex and birth rank reduced the rsd to 359g ($r^2 = 0.08$). Fitting instead the linear indicator traits studied by Waldron *et al.* (1992) gave a rsd of 308g ($r^2 = 0.32$). Fitting both sets and excluding those with insignificant effects gave a rsd of 298g ($r^2 = 0.36$), with the parameter estimates for the most important being presented in Table 4. More than one third of the variation in adjusted leg weight was associated with the effects identified in the table.

TABLE 4: Estimates of effects on leg weight and weight of dissected lean in the leg after adjustment to constant total loin weight

Effect	Adjusted leg weight Regn Coeff. (s.e.)	Signif.	Adjusted Dissected Leg Lean Regn Coeff. (s.e.)	Signif.
GR	-.039 (.004)	***	0.033 (.003)	***
L3	0.039 (.004)	***	0.017 (.003)	***
CL	-.033 (.004)	***	-.025 (.003)	***
CIR	0.057 (.005)	***	0.046 (.003)	***
T	0.134 (.017)	***	0.100 (.013)	***
LL (*10)	0.026 (.004)	***	0.013 (.003)	***
Sire breed		*		***
Sire		***		***
Birth rank		***		*
Residual std dev (g)				
	Above model	301		217
	With addit. effects	297		213

Similar effects were evident when the dissected weight of leg lean after adjusting to constant loin weight was analysed. The within year x slaughter group variation was 267g, reducing to 213g ($r^2 = 0.36$) when the significant effects shown in Table 4 were included in the model. Most of the reduction in variation was associated with linear carcass measurements rather than the effects of breed, sire and birth rank. Sex and carcass weight did not contribute to further reduction in the variance of either trait.

The parameter estimates presented in Table 4 show that, other things being equal, heavier leg joints and a higher yield of dissected lean from the leg, both relative to the weight of meat in the loin, were associated with: shorter carcasses (lower CL); shorter legs (lower T and LL) in both proximal and distal regions; thicker legs (higher CIR); and higher subcutaneous leanness (lower GR) other than in the leg itself (higher L3). Inclusion of additional linear measurements, although significant in themselves, gave little further reduction in the variation of either trait. Most of these other measurements were fat depth measurements taken on the forequarter. All had negative regression coefficients.

DISCUSSION

The addition of conformational measurements to the current carcass classification system results in a significant reduction in the proportion of animals achieving a given specification for animals in which the criteria for selection are indirectly aligned to the specification. The size of the reduction is dependent upon how far the specification deviates from the slaughter population mean, and the correlation of the trait with all other traits in the specification. Specification criteria which were antagonistic (e.g. a shorter than average T with a larger than average CW) obviously resulted in a greater failure to meet the specification than when criteria were positively correlated. The correlations between the various specification criteria and the distance from the current population mean for these traits determines how rapidly the industry can move towards a new 'ideal'. This indicates that the biology of the species must be taken into account when drafting specifications, including examining the correlated responses in other production traits and the economic benefits of alternative strategies compared to that offered by the specification. The aims of including additional measures must also be clear. For example, conformation has been shown to add little to the prediction of carcass composition in sheep (Kempster *et al.*, 1982; Bass *et al.*, 1984), but may well be an important characteristic for the consumer. Consumers may perceive size and shape of specific cuts as quality attributes meaning conformation has a quantifiable economic value, although consumer preferences for cut size and shape have yet to be determined.

The small proportion of animals achieving the three-trait specification indicates that drafting strategy is a vital component in maximising the number of animals achieving a given specification. Results for our analysis of alternative indicators indicated that conformational measurements taken on the carcass were able to predict about one third of the within-draft variation in weight of leg or weight of lean in the leg, without sacrifice to the weight of the loin joint. They thus indicate the potential opportunity that exists for producers and processors to make use of animal variation currently existing within New Zealand sheep flocks. It is also interesting to note that there is potential to uncover additional genetic variation for both traits studied. Approximately 25% of the residual variation was heritable, as judged by the sire component of variation.

Data were not available to test the value of using comparable live animal measurements. Skeletal dimensions and subcutaneous fat depths are likely to be fairly repeatable between live and carcass measurements. The muscle dimensions are less likely to be equivalent as they change markedly from the standing live animal to the hanging carcass. Indeed, there is some evidence to suggest that live animal measurements can be of even greater predictive value of carcass shape and meat yield than the corresponding measurements taken on the carcass (Young and Deaker, 1994).

The identifiable on-farm factors of sire breed, sex and birth rank contributed relatively little to variations in the yield of leg (or of leg lean) relative to loin yield, especially when conformational differences able to be described by the linear carcass measurements were known. This suggests that once a reasonable set of conformational or internal skeletal and muscle measurements is available, they should be of much wider operational utility in accommodating breed, sire, sex and other, as yet unrecognised, sources of environmental variability, than the minimum number now being used. While it is tempting to advocate that such research should be pursued with vigour, it must be coupled with corresponding research on the carcass if feedback signals that are cost effective in practice are to be passed back to producers and breeders.

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