SELECTION INDEXES FOR LEAN MEAT PRODUCTION IN LAMBS

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SUMMARY

Newly-derived genetic parameters for lamb carcase traits were used to construct selection indexes for the genetic improvement of lean meat production in lambs. Selection criterion traits measured at equal weight were predicted to give faster genetic progress in improved carcase composition than those measured at equal age. Selection criteria involving muscle area increased gains in lean content of carcases, compared with using muscle depth.

INTRODUCTION

In sheep industries where meat production from lambs is of importance selection for growth rate or weight for age at less than 6 months results in increased lean and fat weight in carcases (Simm and Dingwall, 1989). Where consumer demand is for lean meat then this selection objective is not appropriate. Simm and Dingwall (1989) proposed an alternative basis for selection using an index with an objective comprising lean weight (LW) and fat weight (FW) being estimated from a selection criterion comprising liveweight (BW), muscle depth (MD) and fat depth (FD). This index has been widely adopted in the British sheep breeding industry with all three criterion traits measured at about 5 months of age. MD and FD are measured by ultrasound scanning at the 3rd lumbar vertebra (Meat and Livestock Commission, 1987)).

The genetic parameters of LW and FW are crucial for accurate selection using this index. These are traits necessarily derived from the dissection of lamb carcases into lean, fat and bone; a time consuming and expensive operation. Understandably few such studies have been reported and hence the number of genetic parameter estimates of LW and FW are small. There is also a variety of endpoints used in different studies at which lambs are killed before dissection. Typically this might be based on a given liveweight but age, fat level or commercial grade are other possibilities. Typically, in Britain, the commercial lamb producer will sell his lambs for slaughter at a given level of subcutaneous fat cover within a narrow weight range. Breeding programmes, however, using the above selection index, provide estimated breeding values for live animal body composition at a given age. Pollott, Guy and Croston (1994a; 1994b) have demonstrated differences in the estimates of heritability and genetic correlations between carcase and dissection traits of lambs when estimated at three common endpoints; fat cover, age and weight. This study was undertaken to investigate alternative selection indexes which may be more appropriate than that currently used for lean meat improvement in Britain.

MATERIALS AND METHODS

The genetic parameters used in this study were derived from lambs slaughtered as apart of a large-scale breed comparison trial carried out on commercial farms in Britain. Previous studies from this trial have been reported by Croston, Kempster, Guy and Jones (1987); Kempster, Croston, Guy and Jones (1987a); Kempster, Croston and Jones (1987b) and Pollott, Guy and Croston (1994a, 1994b and 1994c). These papers should be consulted for details of the trial design and experimental procedures. Pollott et al (1994a) reported estimates of heritability, genetic and phenotypic correlations for 11 traits measured on the carcase whilst Pollott et al (1994b) estimated the same genetic parameters for 17 traits derived from a sample of fully dissected half carcases. These traits included lean, fat and bone weights and percentages as well as various carcase component ratios.

In this study the genetic and phenotypic correlations used were derived between the traits commonly used as selection criterion traits (Pollott et al, 1994a) and those commonly used as selection objective traits (Pollott et al, 1994b), reported by Pollott, Guy and Croston (1994c). The selection criterion traits considered were cold carcase weight (CCWT), carcase length (Len), estimated subcutaneous fat cover (Sfe) muscle width (MW), muscle depth (MD), muscle area (MA), fat depth (FD) and carcase conformation (Conf). MW, MD, and FD were measured on the cut surface of the m. longissimus at the 12th rib whilst MA was computed as the product of MW and MD. Conf was measured on a 15-point scale. The selection objective traits used in this study were LW, FW, lean proportion (LP), fat proportion (FP) and lean:fat ratio (L:F).

The unstated assumption in the selection index of Simm and Dingwall (1989) was that the genetic parameters used were consistent regardless of the endpoint considered. Pollott et al (1994a and 1994b) demonstrate that this is clearly not the case and that endpoint does have an effect on the genetic parameters derived from lamb carcase studies. In particular the very low estimates of heritability derived for LW and FW at the age endpoint (Pollott et al,1994b) cause concern since these are the two traits currently used in the Simm and Dingwall (1989) index. Most traits likely to be used in the selection objective had higher heritablities at the weight endpoint than at the age or fat cover endpoints. In this study, therefore, the correlations used were derived between the selection objective and criterion traits at a combination of different endpoints.

The four different sets of correlations used were derived from the data using derivative-free maximum likelihood (DFREML) techniques with the animal model (Meyer, 1989; and see Pollott et al 1994a, 1994b and 1994c for details). The four sets of correlations estimated were between selection criterion traits and selection objective traits both at the age endpoint (Age/Age), at the age and fat cover endpoints (Age/Fat), both at the weight endpoint (Wt/Wt) and at the weight and fat (Wt/Fat) endpoints respectively. Thus the four sets of correlations correspond with the current selection programme (Age/Age), the commercial situation in Britain (Age/Fat), an alternative to the current age-based index (Wt/Wt) and its commercial application (Wt/Fat).

These four sets of correlations were used to compare the likely improvement in carcase composition of a range of different selection objectives. These selection objectives were LW and FW; LP and FP; and L:F. The relative economic values (REV) of 3 and -1, for the lean and fat traits respectively, were used (after Simm and Dingwall, 1989) for the weight and proportion selection objectives; no economic weight was required for the L:F selection objective since it is a single trait objective. Selection indexes were computed for these selection objectives and the resulting change in carcase composition modelled for the average carcase from the study of Pollott et al, 1994a. Finally a range of other likely selection criterion traits were used to see if genetic progress in carcase composition could be made faster. These additional traits included MA, Sfe, Conf and Len but the last two did not improve the indexes and so are not reported here. All matrices used to compute these indexes were positive definite.

RESULTS

Table 1 Comparative responses to selection in tissue weights (g), tissue proportions (g/kg) and L:F per generation.

Objective	Endpoints	LW	FW	LP	FP	L:F
Tissue wt.	Age/Age	48*	-113	2.3	-6.1	0.060
	Age/Fat	113	20	5.7	1.0	0.015
Tissue prpn.	Age/Age	148	-128	7.6	-6.9	0.087
	Age/Fat	111	-78	5.6	-4.2	0.057
L:F	Age/Age	182**	-182			0.119
	Age/Fat	111	-111			0.071

* Underlined values computed directly as response to selection from using the appropriate index. All other values calculated using an "average" carcase.

** Based on the assumption of equal and opposite response in LW and FW.

The gain in LW and FW computed with population statistics from these data but using the genetic parameters from Simm and Dingwall (1989) were 203 and 78 g/generation. The results for the various alternative indexes, shown in Table 1, indicate the likely response in carcase composition if the genetic parameters derived by Pollott et al (1994a, 1994b and 1994c) are used.

By using the new genetic parameter estimates in the current Simm and Dingwall (1989) index responses of 48 and -113 g/generation in LW and FW are predicted. This is a slower increase in LW but a reduction in FW with a likely correlated loss in weight. All the alternative indexes shown in Table 1 would give a greater response in LW than the current index with a range of different responses in FW from 20 to -182.

The second set of index responses, computed from selection criteria measured at equal weight, are shown in Table 2, following the same method as those computed and shown in Table 1.

Table 2 **Comparative responses to selection in tissue weights (g), tissue proportions (g/kg) and L:F per generation. (Same assumptions as for Table 1).**

Objective	Endpoints	LW	FW	LP	FP	L:F
Tissue Wt.	Wt/Wt	142	-189	7.3	-10.1	0.114
	Wt/Fat	255	24	13.3	1.3	0.042
Tissue prpn.	Wt/Wt	175	-203	9.4	-10.9	0.128
	Wt/Fat	101	-79	5.4	-4.2	0.056
L:F	Wt/Wt	+274	-274			0.179
	Wt/Fat	112	-112			0.071

The selection response in LW shown in Table 2 was always greater than or similar to the corresponding response in Table 1indicating that measuring selection criteria at a constant weight will give as good as or a better rate of improvement than the current age-based indexes. The rate of reduction in FW would also be better or similar using a weight-based index than an age-based index.

The comparative genetic gain in LW and FW using MA and Sfe in the index is shown in Table 3 for a number of different selection indexes.

Greatest genetic gain in LW is predicted to occur using an index of MA, FD and Sfe although this would lead to an increase in FW as well.

DISCUSSION

The results in Table 1 indicate that selection for tissue proportions or L:F would lead to a faster improvement in LW and FW than by selection for LW and FW themselves, at the age endpoint.
Comparing the results in Tables 1 and 2, for selection objective traits at the fat cover endpoint, provides information of how the selection criterion traits should be 'corrected'. Tissue proportion and L:F changes were almost identical when using age or weight as the selection criterion endpoint. However the faster genetic gain in the tissue weight objective was possible using weight as the selection criterion endpoint, LW gain being 255g/ generation, compared to 113 at the age endpoint. FW responses were similar at about 20 g/generation. Further improvements in LW would be possible by substituting MA for MD in the Wt/Fat index at the weight endpoint (Table 3).

The addition of SFe to this criterion would increase LW by a further 45g/generation but lead to an increase in FW gain of 56 g, resulting in the difference between LW and FW gain being similar with or without SFe in the index. At present SFe is not estimated on the live animal as part of the scanning service. The question arises as to whether it would be feasible to take this measurement and whether the measurement taken on the live animal is of equal value to SFe, as measured here on the carcase.

Table 3 **Using MA and SFe as selection criterion traits in indexes at the weight endpoint. REV for lean = 3.**

				Gain (g/ generation)	
Endpoint	Criterion	Index Variance	Correlation index/objective	LW	FW
Wt/wt	MD FD	0.6144	0.4215	142	-189
	MA FD	0.6702	0.4598	154	-210
	MD FD SFe	0.7602	0.5215	165	-264
	MA FD SFe	0.8126	0.5575	177	-282
Wt/SFe	MD FD	0.7406	0.5154	255	24
	MA FD	0.8010	0.5575	275	24
	MD FD SFe	0.8189	0.5699	300	80
	MA FD SFe	0.8783	0.6113	320	78

A further consideration when choosing which index to use must be the net response in LW and FW rather than the absolute values discussed above. If we take the difference in gain between LF and FW, as shown in Table 2, then for the tissue weight objective there is 221 g/generation more LW than FW, 180 g for the tissue proportion objective and 222 g for the L:F objective. Using MA in place of MD increases this difference to 251 g/generation and no gain is achieved by using SFe in the index.

In conclusion, if the age endpoint is used to correct selection criterion traits then tissue proportions or L:F should be used or selection objectives with MD and FD as the selection criterion with or without CCWT. However, faster net gain in LW could be achieved using weight corrected selection criterion traits (FD and MA) with the LW/FW or L:F selection objectives.

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