INTERRELATIONSHIPS BETWEEN GR AND OTHER LAMB CARCASS FATNESS MEASUREMENTS

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SUMMARY

The relationships between carcass weight and various measures of lamb carcass fatness are reported. On average, bigger carcasses have bigger fat measurements. Although carcass fatness could be predicted from carcass weight alone, all fatness measurements improved the accuracy of prediction if combined with carcass weight. Measurements GR and C were equally accurate for predicting carcass fatness, and measurement S2, which would be difficult to measure on an intact carcass, was promising. The best combination of available measurements could account for 74% of the variation in the percentage chemical fat content of the lamb carcasses studied.

It was concluded that the present Meat Producers Board policy of progressively reducing the allowable GR measurement must inevitably result in lighter carcasses being produced by the farmer who wishes to avoid F grade carcasses, unless a series of GR measurements is introduced which allows larger carcasses to have larger GRs without penalty.

INTRODUCTION

GR is a carcass measurement giving total tissue thickness between the surface of a lamb carcass and the rib at a point 11 cm from the mid-line in the region of the 12th rib (Frazer, 1976; Kirton *et al.*, 1978). It is the measurement specified by the New Zealand Meat Producers Board as setting the lower limit of the overfat (F) lamb grade. Interest in overfatness has been stimulated among farmers by the progressive reduction of the GR measurement from 18 mm in the 1973-4 season to 15 mm in the 1978-9 season, with promises of further reductions to come. Because more lamb carcasses are likely to grade F as GR is reduced, with the resulting lowered payment per carcass, farmers are becoming interested in measures designed to avoid this problem. To assist selection against fatness in breeding programmes, Dr A. D. Beach of DSIR has developed an ultrasonic probe for measuring fat thickness in live sheep in the region of measurement C of Palsson (1939).

It is not known whether an overseas consumer judges a cut of lamb to be overfat on the basis of some visual impression of fat thickness (a fat measurement?) or on the relative proportions of fat and lean (percentage composition). Whether some carcass measurements are markedly better than others in indicating total carcass fatness has yet to be established and there is little information on the interrelationships between many of the possible carcass measurements. This report answers some of the above questions and provides carcass data which can be related to market information if this becomes available.

MATERIALS AND METHODS

Measurements GR1 (GR on right side of hot carcass), GR2 (GR on left side of cold carcass cut at last rib), subcutaneous fat thicknesses C, J (Palsson, 1939), S1, S2, L1, L2 (Kirton *et al.*, 1967) and L3 (greatest subcutaneous fat thickness at about mid point of the gluteus medius muscle on cut surface of leg joint where L1 and L2 are also taken), as well as kidney fat and omental fat weights, were taken on 314 Southdown × Romney lamb carcasses. GR3 (GR on left side of hot carcass) was also taken on a limited number of the carcasses. Chemical fat content of these carcasses was measured as described by Kirton *et al.* (1967). Some carcass measurements but not chemical composition were taken on a further 256 Southdown × Romney lambs from the same trial. In addition, the 7 subcutaneous fat measurements (not including GR) were taken and chemical composition measured on 567 (1970 born), 848 (1971) and 798 (1972) lambs from the Ruakura Progeny Trial involving a sire breed comparison over Romney ewes (Carter *et al.*, 1974; Kirton *et al.*, 1974). It should be noted that although GR was not measured in the earlier experiments, this measurement is defined in a manner similar to measurement J.

The data have been analysed by standard regression procedures.

RESULTS AND DISCUSSION

Measurement means, correlation coefficients (above diagonal), regression equations and residual standard deviations (RSD) for various carcass measurements on the 145 Southdown × Romney lambs for which GR was also measured on the left side (GR3) are given in Table 1. The means of the three different GR measurements are similar, with J only being slightly smaller. The positive correlation and regression coefficients indicated that bigger carcasses have bigger measurements. All measurements were positively interrelated and no one measurement could be predicted with a high degree of accuracy from any other measurement.

TABLE 1: MEANS (ON DIAGONAL), CORRELATION COEFFICIENTS (ABOVE DIAGONAL), AND SIMPLE REGRESSION EQUATIONS AND RSD (BELOW DIAGONAL) OF VARIOUS CARCASS MEASUREMENTS ON 154 SOUTHDOWN × ROMNEY LAMBS

X / *Y*	*Hot Carcass (kg)*	*C (mm)*	*J (mm)*	*GR1 (mm)*	*GR2 (mm)*	*GR3 (mm)*
Hot carcass (kg)	16.08 —	0.58	0.63	0.72	0.70	0.64
C (mm)	0.455X − 2.90 (1.53)	4.41 —	0.75	0.71	0.78	0.72
J (mm)	0.944X − 4.69 (2.79)	1.431X +4.18 (2.37)	10.49 —	0.83	0.90	0.82
GR1 (mm)	1.266X − 8.55 (2.90)	1.576X + 4.86 (2.96)	0.966X + 1.67 (2.35)	11.81 —	0.87	0.90
GR2 (mm)	1.057X − 5.20 (2.56)	1.484X + 5.26 (2.27)	0.904X + 2.32 (1.56)	0.747X + 2.99 (1.78)	11.81 —	0.87
GR3 (mm)	1.122X − 6.64 (3.22)	1.610X + 4.29 (2.89)	0.951X + 1.41 (2.42)	0.898X + 0.79 (1.84)	1.016X − 0.61 (2.04)	11.39 —

Means and simple and partial correlations (with carcass weight as a third, fixed variable) are given in Table 2 for 314 lambs where various fat measurements are related to carcass weight, % chemical carcass fat or weight of carcass fat. Weight is the simplest carcass information to collect and is always recorded at point of slaughter. Results show all measurements increase as carcass weight increases and also as fatness increases. The partial correlations show that the various fatness measurements give information additional to that obtained from carcass weight in predicting carcass fatness. In particular, C (the ultrasonic site), GR (Meat Producers Board overfatness measurement), J and S2 appear to be among the better measurements.

TABLE 2: MEAN MEASUREMENTS AND SOME SIMPLE AND PARTIAL CORRELATIONS[1] (CARCASS WEIGHT FIXED) BETWEEN VARIOUS FAT MEASUREMENTS AND PERCENTAGE OR WEIGHT OF CHEMICAL CARCASS FAT IN 314 SOUTHDOWN × ROMNEY LAMBS

Variable	*Mean*	*kg Cold Carcass*	*% Carcass Fat*[2] *Simple*	*Partial*	*kg Carcass Fat*[2] *Simple*	*Partial*
C (mm)	3.9	0.65	0.72	0.47	0.75	0.53
J (mm)	9.6	0.71	0.76	0.50	0.80	0.52
S1 (mm)	2.6	0.61	0.62	0.32	0.68	0.37
S2 (mm)	5.3	0.69	0.73	0.45	0.77	0.47
L1 (mm)	8.0	0.61	0.66	0.40	0.68	0.40
L2 (mm)	12.6	0.59	0.60	0.31	0.63	0.27
L3 (mm)	6.0	0.57	0.64	0.39	0.65	0.38
GR1 (mm) Hot	9.8	0.72	0.73	0.42	0.79	0.46
GR2 (mm) Cut	10.4	0.75	0.74	0.42	0.81	0.45
Kidney fat (g)[3]	185	0.77	0.75	0.43	0.83	0.47
Omental fat (g)	460	0.79	0.74	0.39	0.83	0.43
Carcass wt (kg)	14.1		0.73		0.93	

[1] Correlations pooled within sex.
[2] Mean carcass fat 29.0% or 4.35 kg.
[3] Left side only.

Similar results were obtained from the carcasses of 2213 lambs from a variety of ram breeds mated to Romney ewes over three seasons (Table 3). They were recorded before GR was included in the measurement system, but the J measurement is similar to

TABLE 3: SIMPLE AND PARTIAL (CARCASS WEIGHT FIXED) CORRELATIONS BETWEEN SELECTED CARCASS MEASUREMENTS AND PERCENTAGE CARCASS FAT FOR THREE SEASONS' LAMBS (INVOLVING 12 RAM BREEDS)

	1970-1		*1971-2*		*1972-3*	
	Within[1]	*Total*[2]	*Within*	*Total*	*Within*	*Total*
Simple correlations						
No. carcasses	567		848		798	
Hot carcass (kg)	0.70	0.68	0.77	0.73	0.77	0.69
C (mm)	0.71	0.73	0.75	0.74	0.72	0.74
J (mm)	0.79	0.81	0.73	0.76	0.75	0.77
S2 (mm)	0.82	0.84	0.80	0.82	0.80	0.82
L3 (mm)	0.75	0.78	0.63	0.66	0.76	0.78
Partial correlations						
C (mm)	0.47	0.51	0.48	0.49	0.45	0.54
J (mm)	0.56	0.63	0.46	0.54	0.48	0.58
S2 (mm)	0.63	0.69	0.56	0.63	0.53	0.67
L3 (mm)	0.53	0.59	0.32	0.38	0.50	0.59

[1] Within sire breed and sex groups.
[2] Overall ignoring breed and sex.

GR. Only the five measurements with the highest correlations have been included in the table. The correlations in Table 3 were slightly higher than those in Table 2 and generally confirm the previous results. An interesting finding is the similarity of the results between the situation where breed and sex are known, and can be corrected for if necessary, and the "Total" column which simulates the situation where a carcass grader is passing judgement on a flow of carcasses of unknown breed and sex. Shoulder measurement S2, which is unfortunately found at a site difficult to locate on an uncut carcass, gave the best estimate of percent carcass fat. Very similar results to those in Table 3 were also obtained when the same fatness measurements were related to weight of carcass fat.

Having established some interrelationships between various measurements, and their individual value or value when combined with carcass weight as indicators of proportion of carcass fat, the next questions to answer are:

(1) How closely related to percentage carcass fatness is the best combination of available fatness measurements?

(2) Of the measurements which might be taken in a freezing works, which are best for predicting percentage carcass fat?

An attempt to answer these questions has been made in Table 4. The best combination of 10 measurements could account for about 74% of the variation in carcass fatness ($R = 0.86$). Carcass weight alone could account for just over 50% of the

TABLE 4: SIMPLE/MULTIPLE CORRELATIONS AND REGRESSION COEFFICIENTS (5 VARIABLE EQUATION) SHOWING INCREASED ACCURACY OF PREDICTING PERCENTAGE CARCASS FAT THROUGH THE STEPWISE INCLUSION OF ADDITIONAL MEASUREMENTS (314 SOUTHDOWN × ROMNEY LAMBS)

Variable	*r or R*	*Partial reg. coeff.*[1] ± *SE*	*Sig.*[2]
Cold carcass alone (kg)	0.73	0.275 ± 0.122	*
+ GR1 (mm)	0.78	0.230 ± 0.066	***
+ Omental fat (g)	0.80	0.003 ± 0.002	†
+ Kidney fat[3] (g)	0.82	0.020 ± 0.004	***
+ C (mm)	0.84	0.631 ± 0.132	***
+ 5 other measurements	0.86		

[1] These regression coefficients apply to five variable equation (pooled within sex) with constants of 15.88 for ewes and 14.87 for wethers.

[2] These significance figures refer to the effect of adding the specified variable after the effects of the other four have been accounted for. † = $P<0.10$.

[3] Kidney fat included in total carcass fat; estimated to comprise about 7%.

variation in carcass fatness. In combination with four other measurements, omental fat gave least improvement in prediction, and surprisingly, in the combination, carcass weight contributed less than GR, C or kidney fat weight from one side. In practice, carcass weight would be included because it is recorded anyway; GR or C would be used depending on the availability of suitable measuring equipment; and possibly in the very long term, if increased accuracy was required, kidney fat might be added.

The GR measurement used by export carcass graders will now be considered in greater detail, and the effects of the Meat Producers Board policy of progressively reducing this measurement will be discussed. Although a measurement at a similar location to C taken by introscope is used as a basis for the New Zealand pig grading scheme, and a similar measurement taken by conductivity probe is to be used in the proposed Australian beef carcass classification scheme, the particular measurement to use in a New Zealand lamb grading scheme must depend on relative accuracy of the measurement (for what?), ease of location of measurement site, and availability and suitability of equipment which might be used for taking the measurement.

If accuracy of predicting total carcass fatness is an objective in grading, the GR measurement is as accurate as C. The GR site can be defined as well as that for any alternative measurement. Simple probes are available to measure GR now, and a better probe is being developed. No probe is currently available that can measure C in lamb or mutton carcasses. Although it is widely accepted that in absolute terms C can be measured more accurately than GR, the results in this paper indicate that in relative terms there is little to choose between them (*i.e.*, a 1 mm error in measuring a 4 mm C is equivalent to a 2.5 mm error in measuring a 10 mm GR).

The use of GR from one side of the carcass only, gives an objective method of penalizing farmers producing F grade carcasses although a small proportion of individual carcasses may be misclassified as satisfactory. Up to the present a larger source of error comes from the number of carcasses which should grade F based on their GR value but which do not because they are not measured by the grader. This occurs because of the difficulty in measuring lamb carcasses as they travel down the slaughter chain at 6 to 8 per minute, or faster, with the equipment at present available. This problem may be overcome when a new GR probe which makes measurement easier (A. D. Beach, DSIR, pers. comm.) becomes commercially available. In one recent trial

(Kirton *et al.,* 1978), where carcasses were in a chiller, allowing the grader as much time as he wished, only 19 out of 44 (43%) of those carcasses which could have graded F were picked.

The effect of carcass weight on GR for three groups of lambs from different experiments this past season is shown below:

(1) 72 Southdown × Romney GR1 (mm) = 1.74 Hot c/c (kg) —14.71.

(2) 90 Southdown × Romney GR1 (mm) = 0.98 Hot c/c (kg) + 3.38.

(3) 570 Southdown × Romney GR1 (mm) = 104 Hot c/c (kg) —5.67 = 1.08 Cold c/c (kg) —5.67.

The regression coefficient in equation (3), with most carcasses involved, indicates that for each 1 kg increase in carcass weight, GR is expected to increase on average by just over 1 mm. The equations in Table 1 relating carcass weight to the three different measures of GR and also J lead to a similar conclusion. These results indicate that, if the Meat Producers Board retains its present policy of periodically reducing the GR measurement used to define the cut-off point between acceptable and overfat carcasses, an inevitable consequence is that heavier-than-average carcasses will be penalized by being graded overfat. Until selection and management programmes are developed and operated to overcome this problem, farmers will be encouraged by the Meat Producers Board policy to produce lighter and lighter lambs to avoid overfatness as GR is reduced. This result is contrary to another aim to slightly increase mean carcass weights.

If carcasses that are fatter than average and not just heavier are to be penalized for overfatness, then obviously more than one GR cut-off point is required, with heavier carcasses permitted larger GR measurements. As the present export lamb carcass grading system has three carcass weight ranges, an obvious starting point would be to have different GR standards for each of these ranges. Because most overfat lamb carcasses are heavier than the top weight of the L weight range (Davidson, 1976), specifying different GRs for the M and H weight ranges would be a satisfactory first step.

The export schedule (carcass price/kg in different grades and weight ranges) should be set to discourage fat carcasses and encourage farmers to breed for leaner lambs. While overfat carcasses are heavily penalized financially, under 1% of all carcasses have been so graded to date (Kirton *et al.,* 1978). The P grade (55 to 65% of all lambs) from which an increasing proportion of F grade carcasses will be taken as standards tighten has once again in the 1978-9 season started with a premium over the next leanest Y grade. Thus, if the meat industry has a message for farmers on overfatness, it is disguising it very well.

In conclusion, it should be noted that there may be a conflict between the biological solution and the marketing solution to the problem of overfatness. Biologically, it seems the best solution is to encourage the production of slaughter lambs of below-average fatness for a given weight. However, from a marketing point of view there may be some absolute fat thickness for each market above which customers will not purchase our meat or will discount it heavily. Thus some heavy carcasses from biologically superior lambs may still be overfat in marketing terms. These possibilities make it very important to get as soon as possible the necessary market information on what constitutes an overfat carcass, so that if there is a conflict it can be resolved in New Zealand without impairing the effort to encourage the production of leaner lambs and yet allow production of heavier carcasses without damaging our overseas markets.

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