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Analysis of lamb schedules and relative economic values of lean and fat

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ABSTRACT

Carcass composition data from 1430 carcasses were used to obtain prediction equations for lean weight and fat weight as a function of hot carcass weight (HCW) and GR measurements taken at slaughter.

The equation to predict lean weight was: 0.316+(0.547 x HCW) - (0.070 x GR), $R^2 = 0.91$.
The equation to predict fat weight was: -1.15+(0.223 x HCW) + (0.132 x GR), $R^2 = 0.88$.

A computer simulation program was used to generate data for 100 000 carcasses with log-normal distributions for HCW and GR, and with means (standard deviation) of 14.3 kg (2.4) for HCW and 8.03 mm (3.59) for GR. Lean and fat weights were calculated from the prediction equations obtained from the dissection data. Relative economic values (REV's) of lean and fat were obtained from a multiple regression of carcass value on lean weight and fat weight. Carcass value was taken as HCW multiplied by a mean net schedule price/kg for that export grade of carcass from a national summary. The values were calculated using average prices from each marketing year from 1985/86 to 1989/90. Grades were determined from HCW and GR of each carcass.

The REV of a kg of lean, when a kg of fat was set to -1, ranged from 0.92 to 1.69. There was no obvious time trend in the REV's obtained. The correlation between weight of lean and carcass value ranged from 0.31 to 0.69. The correlation between HCW and carcass value ranged from 0.21 to 0.63.

The results will be used to derive breeding objectives and determine selection strategies for improvement of sheep meat production.

Keywords Carcass, sheep, simulation, lean, fat, relative economic value.

INTRODUCTION

Selection programmes are often motivated by economic incentives. The income from selling lamb is set by the grade/price schedule which is a function of hot carcass weight (HCW) and GR. The GR measurement is defined as the total tissue depth over the 12th rib at a point 11 cm from the midline of the carcass. The carcass that produces the greatest income has a heavy weight and a low GR measurement. Unfortunately, these 2 traits have a positive correlation (Kirton and Johnson, 1979) and therefore carcasses which have a high carcass weight tend also to have a high GR measurement. The lamb schedule is published in $/head for each weight within a grade. The consequences of marketing lambs at different weights and grades under the New Zealand carcass classification system has been reported by several authors, (Bray, 1984; Shadbolt, 1984; Dodd and Pownall, 1985; Garrick *et al.*, 1986; Garrick and Purchas, 1989). There are many different aspects of this topic, including management, feeding, growth rate, and relationship between HCW and GR. The objective of this study was to describe the market signals given by the schedule in terms of relative economic values for lean weight and fat weight in a lamb carcass. These relative economic values are required as part of the development of breeding objectives for export lamb production. They will be used in the weighting of traits in a selection index.

MATERIALS AND METHODS

Carcass composition data from 1430 carcasses were used to obtain prediction equations for lean weight and fat weight as a linear function of hot carcass weight (HCW) and GR. The lambs were from Romney ewes

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mated to Romney, Border Liecester, Dorset or Coopworth rams. Half of each carcass was subjected to full butcher's knife dissection and weights of lean and fat were recorded. Unadjusted means and standard deviations of carcass traits are presented in Table 1.

TABLE 1 Means and standard deviations of carcass traits of 1430 Romney and Romney-cross lambs.

Trait	Mean	SD
HCW, kg	14.59	2.58
GR, mm	6.84	3.07
Lean, kg	7.82	1.32
Fat, kg	3.01	0.99

National weighted grade/price schedules were obtained from NZ Meat and Wool Boards' Economic Service for each marketing year (October 1 to September 30) from 1985/86 through the first 9 months of 1889/90. The summaries had separated total returns into returns from skin and wool and a net carcass return. The prices used in this analysis were exclusive of skin and wool returns and net of all charges. Prices were expressed as $/kg of carcass weight for each of the grades.

A computer simulation program was used to generate data for 100 000 carcasses. The distributions used in the simulation were log-normal with mean (SD) of 14.3 kg (2.4) for HCW and 8.03 mm (3.59) for GR. Pseudo-random normal deviates from the rannor function of SAS (1985) were transformed to a log-normal distribution. A phenotypic correlation of .70 between HCW and GR was assumed. Carcasses were then separated by grade and given a value according to the price/kg of carcass weight from the national summary for each marketing year multiplied by HCW. This product was the carcass meat value. The distributions used were the same as those used by Simm *et al.* (1987). These values give a distribution of lambs similar to the national kill.

The equations obtained from the 1430 carcasses were used to predict the weights of lean and fat as a function of HCW and GR for each carcass in the simulation. Carcass value was regressed on predicted lean and fat weights. The partial regression coefficients which were estimated were interpreted as estimates of the relative economic values of lean and fat. Carcass value was also regressed on HCW and GR and the partial regression coefficients estimated were again interpreted as estimates of the relative economic values of HCW and GR.

Simple and partial correlation coefficients among carcass values for the separate years and weights and GR were computed.

RESULTS

The models used to describe lean and fat weight of the 1430 dissected carcasses as a linear function of HCW and GR explained 91% and 88% of the variation, respectively. The equations subsequently used in the prediction of lean and fat of the simulated carcasses were:

lean wt = 0.316 + (0.547 x HCW) - (0.070 x GR)
fat wt = -1.15 + (.223 x HCW) + (0.132 x GR).

The estimates of the partial regression coefficients of carcass value for each marketing year on lean and fat for the simulated population are presented in Table 2. The ratio of the value of a kg of lean weight when the value of a kg of fat weight was set to -1 is used to compare results across years. There is not an obvious time trend in the ratio. The highest value of the ratio was in 1986 and the lowest was in 1985. The estimates are a function of the carcass schedule used as well as the distribution of carcasses.

TABLE 2 Partial regressions of carcass value on lean weight and fat weight for a simulated population of 100 000 lamb carcasses.

Year	Regressions Fat, $/kg	Regressions Lean, $/kg	Ratio Lean/-Fat
1985/86	-3.69	3.40	0.92
1986/87	-2.33	3.94	1.69
1987/88	-2.40	3.00	1.25
1988/89	-5.41	5.62	1.04
1989/90[a]	-6.55	7.76	1.18

[a] Includes only the first 9 months of the marketing year

The corresponding partial regression coefficients for the 1430 lambs from the dissection data set were considerably different and in some years the relative economic value of fat was positive (Table 3). This group of 1430 lambs had a higher HCW and a lower mean GR than the simulated population. The analysis was repeated with 0.29 kg subtracted from HCW and 1.19 mm added to the GR measurement of each lamb in the data set in order to have means equal to the simulated data set. The partial regression on fat was then negative for each of the 5 years and the rank order of the ratios was the same as for the simulated data set. This suggests that below a certain level of fatness there is not a penalty for fat and that as fat increases the economic penalty increases. The point at which the penalty for fat cancels out the added returns for HCW varies according to the schedule and the population of lambs. This has been addressed by Bray (1984); Garrick and Purchas (1989). As pointed out by Garrick and Purchas (1989), feed availability and drafting strategy are two important additional factors that can change the relative economic values for a particular flock.

TABLE 3 Partial regressions of carcass value on lean weight and fat weight for 1430 Romney and Romney-cross lamb carcasses.

Year	Regressions		Ratio
	Fat, $/kg	Lean, $/kg	Lean/-Fat
1985/86	-0.53***	1.30***	2.45
1986/87	+0.66***	1.91***	-2.89
1987/88	+0.17**	1.27***	-7.47
1988/89	-0.12	2.19***	18.25
1989/90[a]	+0.44*	3.36***	-7.64

* $P<0.05$, ** $P<0.01$, *** $P<0.001$

[a] Includes only the first 9 months of the marketing year

The partial regessions of carcass value on HCW and GR for both data sets (Tables 4 and 5) are also expressed as a ratio; the ratio is the value of a kg of HCW when the value of a mm of GR is set to -1. The partial regressions on HCW and GR are similar to those on lean and fat, in that they have the same rankings. The 1986 year is again the highest value of the ratio and 1985 is the lowest. The 1986 year has the highest ratio for Lean/-Fat and for HCW/-GR.

The simple and partial correlation coefficients among the variables are in Table 6. Comparison of the correlation coefficients across years reveals that the 1986 year had the highest correlations with value. The 1985 year had the lowest correlations.

TABLE 4 Partial regressions of carcass value on GR and HCW for a simulated population of 100 000 lamb carcasses.

Year	Regressions		Ratio
	GR, $/mm	HCW, $/kg	HCW/-GR
1985/86	-0.72	1.04	1.44
1986/87	-0.58	1.63	2.81
1987/88	-0.53	1.11	2.09
1988/89	-1.11	1.87	1.68
1989/90[a]	-1.41	2.78	1.97

[a] Includes only the first 9 months of the marketing year

TABLE 5 Partial regressions of carcass value on GR and HCW for 1430 Romney and Romney-cross lamb carcasses

Year	Regressions		Ratio
	GR, $/mm	HCW, $/kg	HCW/-GR
1985/86	-0.63***	1.06***	1.68
1986/87	-0.37***	1.54***	4.16
1987/88	-0.36***	1.04***	2.89
1988/89	-0.77***	1.77***	2.12
1989/90[a]	-0.96***	2.74***	2.85

[a] Includes only the first 9 months of the marketing year

The correlation between lean and fat weights was 0.86. When partial correlations between carcass value and the other traits were computed the variation among years is decreased. The coefficients vary little across years. The partial correlations between carcass value and fat and between carcass value and GR in 1986 were lower than the other years. In all years the partial correlations between carcass value and fat or GR were negative and less than the simple correlations. The value of the simple correlations is influenced by the strong correlations between fat and lean and between

HCW and GR.

TABLE 6 Simple and partial correlations with carcass value for a simulated population of 100 000 lamb carcasses[a]

Year	Fat (at constant lean)	Lean (at constant fat)
1985/86	-0.05(-0.64)	0.31(0.68)
1986/87	+0.44(-0.42)	0.69(0.68)
1987/88	+0.27(-0.58)	0.59(0.73)
1988/89	+0.08(-0.59)	0.41(0.67)
1989/90[b]	+0.21(-0.54)	0.52(0.68)
Year	**GR (at constant HCW)**	**HCW (at constant GR)**
1985/86	-0.32(-0.66)	0.21(0.63)
1986/87	+0.16(-0.52)	0.63(0.74)
1987/88	-0.03(-0.63)	0.51(0.75)
1988/89	-0.19(-0.62)	0.32(0.65)
1989/90b	-0.08(-0.60)	0.44(0.69)

[a] Partial correlations in parentheses

[b] Includes only the first 9 months of the marketing year

DISCUSSION

The market is paying rewards for lean and is penalizing fat for given distributions of HCW and GR similar to the national summary. These rewards and penalties may not be applicable in all flocks and will not stay constant for a population of lambs as they grow heavier and fatter throughout the year. The values do however, give an overall summary of the values realized by producers from the schedules of the past five years. The market does not appear to be increasing the rewards or penalties over time. In selecting for lean heavy weight lamb, REV's based on historical prices are of limited value unless the economic incentives will remain the same in the future. There may be environmental and market influences in a year that can quickly change the rewards and penalties. The 1986 marketing year, which had the highest ratios of partial regression coefficients and the highest partial correlations between carcass value and fat or GR, also had the highest proportion of lambs in the YL grade (37% compared to an average of 31% over these 5 years). The results in this study are based on the same distribution of lambs being valued in each of the 5 years. This greater proportion of lighter, leaner lambs in 1986 may have caused the market to apply smaller penalties for fat or to pay greater rewards for greater weight. However, it is not clear from this study if such a cause and effect relationship exists.

This study used national average prices. There may be important regional and seasonal differences which have an impact on the relative economic values of lean and fat. If there are important consistent differences, the REV's that a breeder should use in an index will depend on when and where lambs are marketed. The authors are planning to obtain regional and seasonal price information to determine if there are such differences.

This study used linear prediction equations which, although simple to derive, may not describe adequately the relationships among the traits, especially over a wide range of values. The average carcass weight for the marketing years in this study had a range of 1 kg.

This initial study was concerned with lean and fat values relative to each other. In order to make conclusions about returns to a producer, associated costs must also be considered (Simm *et al.*, 1987; Garrick and Purchas, 1989).

CONCLUSIONS

The NZ export lamb grading schedule gives implicit values to lean and fat in a carcass. The value of a kg of lean when the value of a kg of fat is set to -1 has varied from 0.92 to 1.69 over the last five marketing years. The ratio of the values depends on the population of lambs as well as the schedule. Further research is required to determine if there are important regional or seasonal differences in the schedule prices.

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