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Ranking Romney sires on carcass value from a progeny test

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ABSTRACT

Interest in the meat-producing potential of rams of dual-purpose breeds such as the Romney has increased in recent years. To cater for this a group of Manawatu ram breeders have established a progeny test to determine sire differences in carcass value (CV) estimated as the sum of the value of individual carcass parts. In 2000-2001, detailed information was collected on 139 carcasses representing 12 sires. The average carcass weight and CV (± sd) were 14.9 ± 1.9kg and $81.76 ± $10.76 respectively. A stepwise regression model with residual CV as the dependent variable was used to determine whether sire rankings on CV could be satisfactorily achieved by weighing only selected carcass parts. Weight of boneless leg (BL) explained the most variation with an r^2 of 0.84. The addition of the weights of the frenched rack (FR) striploin (ST) each significantly ($P < 0.001$) increased the amount of variation explained ($r^2 = 0.90$), and increased the rank correlation between estimated and actual sire-group rankings from 0.71 to 0.95. A minimal model to rank the sires in this Romney progeny test is CV= -72.06+30.42*FR + 24.39*ST + 12.36*BL. Use of this model would avoid incurring the costs of weighing all carcass parts.

Keywords: lamb carcass value; progeny test; selection objective

INTRODUCTION

The contribution towards overall farm income from prime lambs is increasing (Economic Service, 2001). In the future, the requirements of the consumer will be reflected in the prices producers receive for their product when meat companies introduce yield payment systems whereby those lambs that have a higher percentage of their weight as lean meat, and particularly lean meat in the more valuable cuts, will be rewarded. Although terminal sire breeds are commonly used for the production of prime lambs, lamb producers are increasingly acknowledging that only half the genetics in those lambs comes from the terminal sire and that their dam line equally needs to be able to produce progeny with good carcass characteristics, complementing the attributes of the terminal sire.

It is because of these predicted market signals and changes in payment that the TRIGG group was formed. TRIGG is a group of six Romney breeders from the Manawatu region who share a common aim of improving the carcass attributes of their Romneys. To do this, they have established a central progeny test, with the goal of including carcass value as a trait in their overall selection objective and finding predictor traits for the objective.

Although previous progeny tests measured carcass traits (e.g., Fennessy *et al.* (1993) and Bradford & Spurlock (1972)), carcass value does not appear to have been considered. However, Fennessy *et al.* (1993) found sire differences in weight of lean in the carcass and Bradford & Spurlock (1972) found sire differences in percent trimmed cuts. Estimates of heritability for carcass traits, although again not directly for carcass value, are moderate (Waldron *et al.*, 1992), with heritability estimates for weight of lean and fat in the carcass of 0.37 and 0.33, respectively, which suggests that improvements in carcass traits can be made through genetic selection.

Ideally, all cuts would be weighed to predict carcass value in a progeny test. However, in the long term, this is impractical if a large number of sires is being tested, due to the time and cost involved for both breeders and meat companies. The purpose of this study is to use the results from the pilot year of the progeny test to measure the size of sire differences in carcass value and to determine whether or not a sub-set of carcass measurements can be used to accurately predict carcass value and to rank sires.

MATERIALS AND METHODS

Animals

For the pilot year of the progeny test conducted in 2000-01, two rams were randomly chosen from each of the six breeders, giving a total of 12 rams, each of which was single-sire mated to commercial Romney ewes. The ewes were brought together prior to lambing and run as one mob at a Massey University sheep unit. All lambs were tagged within 12 hours of birth. The average birth date of the lambs was September 1st (range August 15th - September 24th).

At weaning (14th December 2001) all lambs were weighed and about one third of the lambs within each sire by sex sub-group was assigned for slaughter. The remaining lambs continued to be run as one mob and a further weighing and drafting on the same basis took place on January 30th 2001. By ensuring that each sire by sex subgroup was equally distributed between the two slaughter groups, the possibility of sire-effect biases arising from environmental differences between the slaughter times was minimised, thereby improving the chances of detecting true genetic differences between the sires.

Carcass Measurements

Slaughter took place at the Takapau plant of Richmonds Ltd., the morning following the weighing. Table 1 outlines the measurements that were taken. Measurements of CL and GR were made on both sides of the carcass on the day of slaughter once carcasses had

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reached the chiller floor. The carcasses were chilled at 5°C for approximately 29 hours prior to cutting. The same cutter was used on both occasions, however, the boners differed. The carcass was cut and boned into seven cuts with four "extras". Measurements made on both sides of the cut surface caudal to rib 13 included A, B and C and a tracing of the *longissimus* muscles onto tracing film.

Statistical Analysis

All carcass component weights and linear measurements were analysed using the general linear model procedure in SAS (SAS, 2000). The model included fixed effects of birth rank, sex, slaughter group and sire. Carcass weight was not included as a covariate as the aim of the analysis was to rank sires on their carcass value. Birth date was considered as a covariate, however, it did not have an effect on the results and so was excluded.

Actual carcass value per animal was estimated as the sum of the values of the individual carcass parts (price per kg x weight in kg), using prices provided by the meat company (Table 1). To determine the set of measurements required to best predict carcass value, a step-wise regression analysis was conducted (SAS, 2000). Residual carcass value (RCV) was used as the dependent variable to eliminate the effects of birth rank, sex and slaughter group. All measurements collected (CW, CL, GR, NF, F, FR, BL, BS, FI, ST, MT, FT, LB, BN, A, B and C) were provided as variables for inclusion in the model. This provided model equations for RCV that were then used to rank sires on the basis of their predicted RCVs. The correlation between actual and predicted sire rankings calculated using Spearmans rank correlation (SAS, 2000). The overall mean was added back to the RCV to give carcass values.

RESULTS

Data were collected on 139 individuals. Raw means (±sd) for the measurements recorded on all animals are presented in Table 1.

There was an $8.55 difference in carcass value between Sire 12 (the lowest value) and Sire 8 (the highest value) (Table 2). The difference between these two sires was the only significant difference ($P<0.05$), although the differences between Sire 12 and Sires 5, 6 and 7 approached significance ($P<0.1$). No significant between-sire differences existed for any of the of the other carcass measurements that proved to be useful as predictors of carcass value as outlined below.

Boneless leg weight (BL) was the best single predictor of differences in RCV explaining 84% of the variation. The rank correlation between the predicted and actual rankings of the sires using BL alone as a predictor (equation for CV1 below) was 0.71.

Three further models (equations for CV2, CV3 and CV4 below) were evaluated by adding the weight of FR, ST and BN as they were the 2nd, 3rd and 4th best variables behind BL weight for explaining variation in CV in the stepwise regression analysis. With the addition of each variable the amount of variation explained increased, with model CV4 explaining 90% of the variation. When the rankings of the sires under this model were compared with rankings for actual RCV, the similarity increased, with a rank correlation (RC) of 0.95. The four models created were:-

CV1= -70.49 + 21.99*BL (r^2=0.84 and RC=0.71)

CV2= -71.57 + 30.08*FR + 14.89*BL (r^2=0.88 and RC= 0.76)

CV3= -72.06 + 30.42*FR + 24.39*ST + 12.36*BL (r^2=0.89 and RC=0.95)

CV4= -69.82 + 35.95*FR + 28.41*ST + 12.88*BL – 2.71BN (r^2=0.90 and RC=0.95)

Table 3 shows the actual carcass values (RCV plus the overall mean of $84.22) and predicted carcass values using each of the four models, and includes their ranking within each model.

TABLE 1: Description of carcass parts used in Romney progeny test and their value where appropriate ($ per/kg, February 2001) and raw means and standard deviations for carcass measurements (all weights are in kg, and linear measurements in mm)

Carcass Part	Description	Value	Mean±sd
Carcass Weight (CW)	Hot carcass weight taken on slaughter floor		14.94±1.90
Carcass Length (CL)	Taken from the top of the gambrel as it passes through the hind leg to the lowest part of the hanging carcass in the region of the humerus bone. [1]		976.2±34.2
Fat Depth (GR)	Total soft-tissue thickness 11cm from midline at 12th rib		6.17±3.14
Longissimus Depth (A)	Maximum depth of longissimus muscle[2]		54.46±3.64
Longissimus Width (B)	Maximum width of longissimus muscle[2]		26.22±2.34
Longissimus Fat Depth (C)	Fat depth above longissimus depth[2]		2.94±1.34
Neck fillet (NF)	Both sides weighed together[3]	8.19	0.28±0.05
Flaps (F)	Weight of flaps from rack and loins bone in[3]	1.89	1.66±0.28
Frenched Racks (FR)	Weight of 8-rib frenched racks[3]	24.71	0.79±0.12
Boneless Legs (BL)	Weight of boneless chump-on legs[3]	8.71	3.21±0.40
Boneless Shoulder (BS)	Weight of boneless five-rib shoulder[3]	4.59	2.17±0.30
Fillets (FI)	Weight of boneless fat-free fillets (tenderloins) from both sides[3]	22.66	0.09±0.02
Striploins (ST)	Weight of boneless fat-free loin-eye striploins[3]	28.83	0.34±0.06
Muscle trim (MT)	Weight of muscle trim (>65% chemical lean)[3]	1.80	0.79±0.23
Fat trim (FT)	Weight of fat trim (15-20% chemical lean)[3]	1.07	1.10±0.34
Leg bone (LB)	Weight of hind leg bones (femur, tibia and patella)[3]	0.96	0.97±0.12
Other bone (BN)	Weight of all other bone from both sides[3]	0.96	3.56±0.51

[1]Moxham & Brownlie (1976)
[2]Palsson (1939)
[3]Meat New Zealand (2000)

TABLE 2: Least-squares means (±se) by sire for carcass value (CV) and the weights of carcass (CW), boneless leg (BL), frenched rack (FR) striploin (ST) and bone (BN).

Sire	No.	CV ($)[1]	Weight (kg)				
	c/c		CW	BL	FR	ST	BN
1	12	81.94±2.85[ab]	14.8±0.5	3.19±0.03	0.80±0.02	0.35±0.01	3.49±0.11
2	8	81.64±3.47[ab]	15.2±0.6	3.15±0.04	0.79±0.02	0.32±0.02	3.57±0.13
3	10	80.49±3.08[ab]	15.1±0.6	3.24±0.04	0.75±0.02	0.32±0.01	3.59±0.12
4	10	80.47±3.16[ab]	14.7±0.6	3.18±0.04	0.77±0.02	0.34±0.01	3.56±0.12
5	11	83.23±2.98[ab]	15.1±0.5	3.15±0.04	0.82±0.02	0.36±0.01	3.62±0.11
6	11	83.15±2.98[ab]	15.1±0.5	3.28±0.04	0.81±0.02	0.35±0.01	3.59±0.11
7	15	82.64±2.52[ab]	15.0±0.5	3.26±0.03	0.82±0.01	0.33±0.01	3.52±0.10
8	15	84.93±2.55[b]	15.5±0.5	3.40±0.03	0.81±0.02	0.35±0.01	3.65±0.10
9	9	82.75±3.52[ab]	15.5±0.6	3.27±0.04	0.80±0.02	0.32±0.02	3.73±0.13
10	12	82.14±2.95[ab]	14.8±0.6	3.24±0.04	0.77±0.02	0.37±0.01	3.52±0.11
11	11	80.35±3.00[ab]	14.5±0.5	3.10±0.04	0.79±0.02	0.35±0.01	3.51±0.11
12	16	76.38±2.55[a]	13.9±0.5	2.98±0.03	0.75±0.02	0.32±0.01	3.39±0.08

[1]means within a column without a common superscript letter differ at the 5% level

TABLE 3: Romney sire rankings on carcass value (CV) ($ rounded to the nearest 10 cents) comparing actual CV with predicted CV from four models (Stepwise inclusion of weights of boneless leg (CV1), frenched rack (CV2), striploin (CV3) and bone (CV4))

Sire	CV Ranking (CV)	CV1 Ranking (CV)	CV2 Ranking (CV)	CV3 Ranking (CV)	CV4 Ranking (CV)
1	7 (84.50)	9 (83.90)	7 (84.30)	7 (84.60)	7 (84.70)
2	8 (84.10)	8 (84.00)	5 (84.60)	9 (84.30)	9 (84.10)
3	9 (83.00)	4 (85.70)	9 (84.10)	10 (83.40)	10 (82.90)
4	11 (82.80)	7 (84.80)	6 (84.50)	8 (84.50)	8 (84.30)
5	4 (85.60)	10 (83.20)	8 (84.30)	5 (85.00)	6 (84.80)
6	3 (85.80)	3 (86.10)	3 (86.20)	3 (85.30)	3 (86.40)
7	5 (85.30)	5 (85.10)	4 (85.50)	4 (85.20)	4 (85.60)
8	1 (87.40)	1 (88.30)	2 (87.60)	1 (87.20)	1 (87.30)
9	2 (87.10)	2 (87.50)	1 (87.60)	2 (87.00)	2 (86.90)
10	6 (84.70)	6 (85.00)	10 (84.04)	6 (84.70)	5 (85.00)
11	10 (82.80)	11 (81.40)	11 (81.90)	11(82.40)	11 (82.30)
12	12 (78.70)	12 (77.80)	12 (78.00)	12 (77.90)	12 (78.10)

DISCUSSION

Practicalities

For each slaughter group, three days of input were required. On the first day, drafting for slaughter took place, which involved weighing all lambs and then sorting them by sire and sex to establish slaughter groups. On the day of slaughter, three people were required to enable accurate tag recording and identification of carcasses. GR and carcass length measurements recorded on day of slaughter were made by a Richmond grader with the assistance of two others. On the day following slaughter, carcass cutting took place; this required four, trained boners/cutters and packers. Four people were required to make measurements on the *longissimus* muscle and record the weights of the cuts of meat. Cutting the carcasses took approximately 8 hours per slaughter group. This process required a significant input of human resources that could be appreciably reduced if only a selection of cuts needed to be weighed.

Mean and Variation in Carcass Traits

The average CW of lambs slaughtered of 14.9±1.9kg, is below the national average of 16.65kg (MWESNZ, 2001). However, 67% of the carcasses fell within the desired "M" weight range (13.3-17.0kg). The average GR was 6.17±3.14mm, so only 7% of the carcasses met the criteria of the popular export class YM grade (13.3-17.0kg CW and 6-7mm GR). This was due to the large variation in GR measurements, which ranged from 1.5mm to 16.5mm, reflecting the slaughter criteria imposed, which involved selection of the heaviest animals within sire by sex groups irrespective of their level of finish (fat covering). This selection criterion meant that the standard deviations for fat measurements GR and C were larger than those likely to be experienced on commercial farms, but this was an unavoidable consequence of endeavouring to ensure that unbiased estimates of sire genetic differences between sires in CV were obtained.

Carcass Value

Carcass value was calculated using the value of the cuts as of February 2001, and although these values fluctuate between years, the relativity between cuts should remain similar.

The $8.55 difference in least-squares means for CV between Sires 8 and 12, in addition to being statistically significant, is of practical significance for the breeders involved. The overall monetary impact on the wider population of commercial breeding ewes serviced by the TRIGG rams will be assessed using a simulation model similar to that described by Johnson *et al.* (2002). Such a systems analysis incorporating a cost benefit analysis for the breeders involved, will be carried out when data for more than one season is available.

Accuracy of Prediction

Given that a significant sire effect on CV was found, the TRIGG breeders plan to continue with the progeny test scheme. However, given the labour required, it would not remain viable in the long term to carry out a detailed collection of all the carcass measurements reported here. Ideally, a subset of measurements would be collected that

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Ranking in model CV3 saw six sires rank in the correct order, and only Sire 4 was displaced by more than one position. These incorrect rankings could be explained by the small differences that existed between the sires for actual carcass value.

Carcass weight did not significantly account for the variation seen in RCV. It is likely that the effect of CW was eliminated through adjusting to a common sex and birth rank. Carcass weight would likely play an important role in model equations if an unrecorded progeny test were used in cases in which birth rank details were not collected on the animals.

Implications

This work has shown that sire differences for carcass value do exist within TRIGG flocks. The difference in carcass value between the best and worst sires likely constitutes a difference useful to commercial farmers, however, a modelling exercise is required to fully investigate the financial benefits. Weighing all carcass components to estimate carcass value is not feasible in the long term due to the labour involved, however, a model has been derived which accurately predicts carcass value and ranks sires. Although the actual and predicted rankings were not identical, this was likely due to the small differences in carcass value between some sires. In the first official year of the progeny test (2001-2002), 24 sires are being used. A full set of data is to be collected on all of the cuts from these sires, and will be used to test the accuracy and usefulness of the model reported here across a greater number of sires.

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