PREDICTION OF LAMB CARCASS YIELD USING VIDEO IMAGE ANALYSIS

D.L. HOPKINS[A], N.M. FOGARTY[B] and B.A. MacDONALD[C]

[A]NSW Agriculture, PO Box 242, Cowra, NSW 2794, Australia
[B]NSW Agriculture, Forest Rd, Orange, NSW 2800, Australia
[C]NSW Agriculture, PO 1208, Crows Nest, NSW 2065, Australia

Keywords: Lamb, video, yield, carcass

INTRODUCTION

Measurement of lamb carcasses commercially in Australia has progressed in recent years to the stage where the fat depth of carcasses can be routinely measured on the chain using a probe, albeit manually. Combined with carcass weight this can serve as a practical way of estimating meat yield (Hopkins *et al.* 1995). This system requires strict monitoring to maintain accuracy levels and a dedicated operator. Development of a video based system called VIASCAN® offers the potential of an on-line automatic system for estimating meat yield overcoming the limitations of the present system and also allowing other carcass characteristics to be measured such as muscularity (Hopkins 1996). Several studies have been published on this system as applied to beef carcasses (Jones *et al.* 1995; Ferguson *et al.* 1995) and these have shown that under most conditions the VIASCAN® system is as accurate as standard carcass measures for estimating yield. Recent work by Horgan *et al.* (1995) in the UK using a similar approach to VIASCAN® showed that when a number of shape measurements were used in combination with carcass weight, a more accurate estimate of percentage meat yield could be obtained for lamb carcasses, than by using the standard MLC scores. The potential to use VIASCAN® as an alternative to current Australian systems for estimating various lamb carcass characteristics and meat yield has been studied in the last few years. The work reported here reports on some of these results.

EXPERIMENTAL METHODS

Measurements

Data for 279 cryptorchid carcasses were obtained representing 6 genotypes; (Texel x Border Leicester/Merino (T x BLM), Poll Dorset x Border Leicester/Merino (PD x BLM), Texel x Merino (T x M), Poll Dorset x Merino (PD x M), Border Leicester x Merino (BL x M) and Merino (M x M)). All lambs were slaughtered under commercial conditions. Following exit from the final wash, an image of each carcass from the dorsal view was obtained on the moving chain using a prototype VIASCAN® video image analysis system with the camera in a fixed position perpendicular to the carcass *(VIASCAN® is the registered trade name of Video Image Analysis Systems developed by the Meat Research Corporation, Australia)*. From the images a range of variables (n=45) were recorded including linear carcass dimensions and descriptions of colour at selected positions on the carcass (Hopkins 1996). The system recognised the bottom of the gambrel where it passes through the Achilles tendon. This was used as the reference for all linear dimensions as was the most distal junction of the hindlegs where the M.*semimembranosus* muscles meet (groin), and the distal end of the neck equivalent to the atlanto-occipital articulation. Each carcass was weighed hot (HCW) and the GR was measured in the chiller within 3 h of slaughter, using a GR knife. Of the carcasses 102 were subsequently prepared into retail cuts based on stratified weight within each of the 6 genotypes (6 x 17). The cross-sectional area of the M. *longmissimus thoracis* was determined by measuring the length and the width of the muscle and multiplying this value by 0.008 (EMA).

Cutting procedure

Carcasses were broken down into primals using a bandsaw. Both boneless (silvertop roast, round, topside, silverside, boneless loin, eye of loin, fillet and neck fillet roast) and bone-in cuts (chump, ribloin-7 rib, shoulder, shank and neck) were then prepared by an experienced butcher. A full description of cut preparation is given by Hopkins *et al.* (1994) and two combinations of these 'trim' cuts plus lean and sausage can be prepared where Yield 1 includes the boneless loin and silvertop roast and Yield 2 includes the eye of loin, topside and silverside. For both combinations (Yield 1 and 2) the rest of the carcass is prepared into the same cuts, but the weight of trimmings, waste fat and bone varies. Each yield type was calculated as a percentage of cold carcass weight. Examination of the video images post-slaughter revealed that a number were of less than desirable quality due to factors such as carcass distortion and interference from steam. A number of carcasses were also trimmed during dressing. Consequently the sample was reduced to 233 and of these 84 were boned (T x BLM=16; PD x BLM=14; T x M=13; PD x M=13; BL x M=14 and M x M=14).

Statistical analysis

Prediction equations for both yield types were developed using regression analysis based on standard carcass measures HCW, GR and EMA and VIA measurements. Given the large number of VIA measurements a correlation matrix was formed to identify those measurements associated with the yield end points. The first step in the analysis using standard carcass measures was the use of simple linear regression to test the influence of HCW on the estimation of each yield type. Thereafter, multiple regression was used to identify the effect of adding the independent variables GR and EMA. Variables were retained in the models if they were significant at P=0.05, and attention was paid to the correlation matrix of the regression coefficients to avoid collinearity. The effect of genotype (1-6) on yield prediction was examined.

Table 1. Mean (±s.d.) and range of carcass measurements and percentage of saleable meat for carcass prepared as 'trim' cuts (n=84)

Hot carcass wt (kg)	Cold carcass wt (kg)	Hot GR (mm)	Cold GR (mm)	EMA (cm^2)	Yield 1(%)	Yield 2(%)
25.2 ± 2.51	23.5 ± 2.49	12.5 ± 2.84	13.0 ± 3.12	14.7 ± 2.39	67.5 ± 2.25	66.6 ± 2.28
(20.0 - 30.0)	(18.6 - 28.4)	(5.0 - 18.0)	(5.0 - 18.0)	(10.0 - 21.0)	(61.8 - 72.2)	(60.8 - 71.3)

RESULTS

The carcasses were heavier (Table 1) than generally found at the domestic retail level and heavier than used to derive the original yield data on which current VIA predictions are based (Hopkins *et al.* 1995), but were of similar fatness based on GR.

Yield prediction

Models allowing estimation of the percentage of saleable meat (Yields 1 and 2) are presented in Table 2. Models based on HCW alone do not explain significant amounts of the variation in yield percentage irrespective of type, but inclusion of GR significantly increased the variance explained. A dramatic improvement was found when EMA was included with HCW and GR.

Table 2. **Models and regression coefficients for predicting the percentage of saleable meat from carcasses prepared as 'trim' lamb using independent variables hot carcass weight (HCW), hot GR, eye muscle area (EMA) and VIA (1 and 2) measurements. R^2 and r.s.d values in brackets show the improvement when genotype is added to the respective models**

Yield	Intercept	Independent variables	R^2	r.s.d.
1	70.6 (±2.48)	- 0.12 (±0.10) HCW$^{n.s.}$	0.02	2.25
1	70.0 (±2.31)	- 0.07 (±0.11) HCW$^{n.s.}$ - 0.35 (±0.09) GR	0.16	2.09
1	69.8 (±1.93)	- 0.28 (±0.11) HCW$^{n.s.}$ - 0.36 (±0.08) GR +0.63 (±0.10) EMA	0.42(0.47)	1.74(1.68)
1	64.0 (±4.13)	- 0.03 (±0.01) VIA1 + 0.02 (±0.007) VIA2	0.14(0.27)	2.11(1.96)
2	70.7 (±2.49)	- 0.16 (±0.10) HCW$^{n.s.}$	0.03	2.25
2	70.0 (±2.28)	- 0.05 (±0.10) HCW$^{n.s.}$ - 0.38 (±0.09) GR	0.20	2.06
2	69.8 (±1.92)	- 0.29 (±0.11) HCW - 0.39 (±0.08) GR + 0.61 (±0.10) EMA	0.44(0.50)	1.73(1.65)
2	62.9 (±4.13)	- 0.03 (±0.01)VIA1 + 0.02 (±0.007)VIA2	0.16(0.29)	2.11(1.96)

n.s., not significant

The best models based on VIA measurements explained similar amounts of the variation in yield, as the current standard carcass measures HCW and GR. The variance explained however was low. There was a significant effect ($P < 0.05$) of genotype on the prediction of yield whether by standard carcass measures, or VIA measurements and this is illustrated in Table 2.

DISCUSSION

The models derived in the current study for predicting yield based on the standard carcass measures, weight and GR were much less accurate than those reported by Hopkins *et al.* (1995). Additionally much less (70%) of the variation in yield was accounted for by the independent variables weight and GR. It is apparent that the range of genotypes has largely caused this affect given that the report of Hopkins *et al.* (1995) was for lamb carcasses of a single genotype and the improvement in model accuracy (see Table 2) when genotype was included. Related to this there was a dramatic improvement in model accuracy when eye muscle area was included as an independent variable an effect not seen when the same genotype is used (Hopkins *et al.* 1995).

The most notable result of our study was the similar predictive accuracy achieved by using VIASCAN® compared to standard carcass measures, which was a similar outcome for beef carcasses (Ferguson *et al.* 1995) . Ferguson *et al.* (1995) did not find a dramatic improvement in predictive accuracy when using VIASCAN® over a range of carcass types whereas Jones *et al.* (1995) reported a significant improvement for carcasses weighing between 250 and 400 kg. However segmentation of carcasses by Ferguson *et al.* (1995) into market categories revealed that there was improvement when using VIASCAN® over conventional carcass measures for carcasses from grass fed beef suitable for the Japanese market (270 to 370 kg).

CONCLUSIONS

For yield prediction of lamb carcasses our data indicate VIASCAN® has potential to replace existing systems given further validation, but commercial implementation would require practical issues to be resolved such as unit reliability and interference from steam and inks.

ACKNOWLEDGMENTS

The financial support provided by NSW Agriculture to undertake this study is acknowledged as is the co-operation of the staff and management of the Cowra abattoir. Thanks goes to Mr T.A. Markham, Ms J.E. Morgan, Mr D.J. Menzies, Mr J.D. Costello and Mr D.F. Stanley for their dedication and assistance with various aspects of this project. The image analysis equipment, software and operation were provided by the Meat Research Corporation using the services of System Intellect, Perth, Australia and the assistance of Mr A. Benn is especially noted. The contribution of both organisations is acknowledged and appreciated.

REFERENCES

Ferguson, D.M., Thompson, J.M., Barrett-Lennard, D. and Sorensen, B. (1995). *Proc. 41st Inter.Congr. Meat Sci.* San Antonio, USA. pp. 183.

Hopkins, D.L. (1996). *Meat Sci.* **44**:307.

Hopkins, D.L., Wotton, J. S. A., Gamble, D. J., Atkinson, W. R., Slack-Smith, T. S., and Hall, D. G. (1994). *Proc. Aust. Soc. Anim. Prod.* 20:156.

Hopkins, D.L., Wotton, J. S. A., Gamble, D. J., Atkinson, W. R., Slack-Smith, T. S., and Hall, D. G. (1995). *Aust. J. of Exp. Agric.* **35**:33.

Horgan, G.W., Murphy, S.V. and Simm, G. (1995). *Anim Sci.* **60**:197.

Jones, S.D.M., Richmond, R.J. and Robertson, W.M. (1995). *Meat Focus Int.* **4**:59.