Australasian Agribusiness Review - Vol.15 - 2007

Paper 8

ISSN 1442-6951

A Hedonic Model of Lamb Carcass Attributes[1]

Terence C. Farrell and David L. Hopkins

Dr Terence Farrell, UNE, Armidale, NSW

Dr David Hopkins, NSW DPI Centre for Sheep Meat Development, Cowra, NSW

Abstract

Lamb carcass value is widely reported to be a function of lean meat yield, which is the relationship between muscle, fat and bone. Five retailers and five wholesalers assessed 47 lamb carcasses from diverse genotypes and scored seven attributes. A hedonic model reveals that conformation attributes were more highly valued (16 c/kg) relative to yield characteristics (4 c/kg). Meat colour and fat distribution were significant for retailers, but less important for wholesalers. Genotype was not a strong indicator of conformation. Eye muscle area and depth were correlated with Fat C; however, these were not significant. These results indicate that carcass conformation, meat colour and fat distribution should be incorporated into carcass grading models.

Key Words

Hedonic, lamb, attributes, conformation and meat value.

Introduction

Differences in quality perceptions exist between buyers and sellers of meat products. This difference may be explained by the economic values attributed to various carcass features (Freebairn, 1973). In this research we examine the value of a range of meat quality attributes as assessed by a group of meat wholesalers and retailers that supply the Sydney market.

Carcass weight and fat are the two leading predictors of lean meat yield (Hopkins, 1994). Lean meat yield has been reported to be positively related to profitability (Hopkins, Hayhurst and Horcicka, 1992). Many research programs have focused their efforts on achieving higher levels of lean meat yield including work on animal growth rates, double muscling, fat reduction and fat translocation.

Sporleder (1972) analysed consumer attitudes toward lamb cuts and found that 'appearance before cooking' was the most important characteristic. Alternatively he found that the least important characteristic was 'lean versus fat'. Approximately eight per cent of the consumers in Sporleder's study claimed that they did not repeat their purchase due to the fat content of the meat. This provides some evidence that muscle or cut shape may be more important relative to fat in determining retail value.

Mullen and Wohlgenant (1991) analysed consumer preferences for lamb loin chops derived from carcasses that were 17 and 23 kilograms carcass weight with fat scores of 5 to 12 mm. Their contingent valuation approach revealed that consumers were not prepared to pay more for a loin chop with a larger eye muscle area relative to a standard loin chop from a 17-kilogram carcass.

The former Meat Research Corporation (now Meat and Livestock Australia) aimed to minimise the perception of lamb as being a fatty product. Its approach was to develop the Large Lean Lamb program. The Large Lean Lamb program had aimed to produce carcasses that were 22 kilograms in carcass weight and which had between 6-15 mm of tissue at the GR site (tissue including fat depth at 110 mm from the back line over the 12th rib). Cryptorchid lambs were promoted to the domestic retail industry to achieve higher carcass weights while producing leaner carcasses. The promotion of these carcasses met some resistance from supply chain participants and it was important to identify the basis of the difference between retailer and wholesaler perceptions of the various lamb attributes. It was assumed that some of the resistance was due to the lack of suitability of Large Lean Lamb for traditional retail cuts, which would support the results of Mullen and Wohlgenant (1991). Trim Lamb (Lamb muscles that were denuded of subcutaneous fat and bone) was introduced to the retail market and its advantage was that it was lean and muscles from larger animals could be cut into suitable portion sizes for smaller families. Once muscles were removed from the bone for Trim Lamb their appearance changed and it was difficult to pick the difference between muscles from an animal with good conformation versus an animal with poor conformation when the carcasses had the same body weight. It was expected that the focus on boneless cuts would decrease the emphasis on conformation as a highly valued lamb carcass trait.

Good conformation was typically associated with sheep breeds such as Dorset or Suffolk or second cross lambs that were produced from Border Leicester and Merino cross ewes with a Dorset or Suffolk ram. These animals were considered meat sheep whereas Merinos or first cross sheep were favoured for their wool (O'Halloran, 1991). The meat sheep breeds attracted higher saleyard prices relative to wool breeds. The meat breeds grew faster and were often younger (6-10 months versus 10-14 months) when slaughtered which also influenced meat and fat colour. A problem with the meat sheep breeds was that they matured early and therefore produced higher levels of fat when grown to higher weights (above 22 kilogram carcass weight). Producers quickly recognised this problem and responded by joining meat breed rams directly to Merino ewes, which enabled the lamb to grow larger without producing as much fat. Meat processors and wholesalers increased their prices for the new first cross lambs; however, prices did not rise to the market value of second cross lambs.

A large study was initiated to investigate the production and processing differences between various breeds of lambs to determine which breeds would be more suitable to produce larger leaner carcasses and to investigate their meat quality under the same environmental conditions (Fogarty, Hopkins and van de Ven, 2000). The following analysis relies on data carcass recorded from that project.

Methods

Five independent meat retailers were invited to assess carcasses and other lamb attributes due to their experience with boneless lamb products. Five lamb wholesalers, four from Sydney and one from Canberra, also participated and these wholesalers supplied approximately one third of Sydney's independent butcher shops (Hopkins, 1995a). The retail group sold a range of product that was considered higher value and its stores were located in suburbs with a greater proportion of high-income families.

Data

The carcasses were a mix of 16 ewes and 31 cryptorchids from six genotypes. The aim was to value a diversity of lambs with differing weights and fat scores, conformations and fat distributions. The retailers and wholesalers were asked to score the lambs for fat distribution, fat level, meat colour, conformation of the hind legs, loin and forequarter, and overall conformation. The scoring range was 1 to 5 with 1 equal to very good, 2 good, 3 acceptable, 4 poor and 5 very poor (Hopkins, 1995a). The retailers were asked to value the carcass in cents per kilogram at their buying price and wholesalers were asked to value the carcasses at their selling price. Both groups also assessed conformation using the EUROP system (de Boer, 1992) where E represented excellent conformation, U good, R average, O poor, and P was very poor conformation.

Additional carcass information was collected including yield (defined by Hopkins and Fogarty, 1998), weight, GR (tissue depth over 12th rib 110 mm from back line), Fat C (tissue depth over 12th rib 50 mm from back line), eye muscle depth (height of longissimus dorsi at 12th rib), width (width of longissimus dorsi at 12th rib) and area (cross section measure of longissimus dorsi at 12th rib), genotype, muscle weight (trimmed weight of primals in grams), fat weight (weight in grams of the fat trimmed from primals) and bone to muscle ratio.

Correlations

The variables Fat C, genotype, and bone to muscle ratio were dropped from further analysis due to their lack of correlation with the market values nominated by the retailers and wholesalers or other variables. The fact that genotype was not correlated with other variables was surprising given the market premiums that were available for second cross animals in livestock markets. Eye muscle length, depth and area were highly correlated with each other but they did not correlate highly with the remaining variables and were removed from further analysis. The EUROP score was also poorly correlated with other variables and in particular the conformation scores and it was also excluded.

The nominated carcass values provided by the wholesalers and retailers were adjusted to prices for Thursday 18th January 2007 to analyse current attribute values (NLRS 2007). The means and standard deviations for the variables that were used in the analysis are reported in Table 1.

Table 1 Means and standard deviations for the retained variables

Description	Variable	Mean	Std. Dev.
Fat Distribution	FD	2.64	1.07
Fat Level	FL	2.81	1.12
Meat Colour	MC	2.61	0.93
Conformation Hind	CH	2.53	1.11
Conformation Loin	CL	2.74	1.10
Conformation Forequarter	CF	2.71	1.02
Predicted Yield	Y	2.90	1.08
Carcass Weight[a]	CWT	25.40	2.75
Fat Score[b]	GR	14.04	2.73
Muscle Weight[c]	MWT	2626.58	291.50
Fat Weight[d]	FWT	735.48	128.25

a measured in kilograms for hot standard carcass weight; b fat depth in mm over the 12th rib; c yield of trimmed, boneless primals in grams; d fat weight from trimmed primals in grams.

The correlation matrix for the variables analysed in the model is shown in Appendix 1. A correlation of 0.6 was set as the minimum cut-off level and each of the attributes has at least one correlation of 0.6 or above. The correlation between fat level and distribution was 0.76, which indicates that these two variables were similar. Fat distribution was also correlated with conformation of the loin (0.72) and forequarter (0.66), which indicated that these were the regions that the assessors used to examine fat distribution. It was interesting that the conformation of the hind was not used to the same extent as the forequarter. Meat colour was primarily assessed from the hind (0.61) and this may be due to the absence of subcutaneous fat. The correlation between carcass weight and fat score was 0.60, which indicated that as weight increased so did the fat score. As expected the carcass weight and muscle weight were highly correlated (0.88). GR was not highly correlated with fat level, fat distribution or expected yield and it was surprising that this information was not used more in the assessment process. The correlation between GR and fat weight was 0.59, which indicates that GR was not a fully robust indicator of total fat. Given that the GR is a measure of tissue depth, which includes both fat and muscle, then an alternate site might need to be identified to improve predictability. Nonetheless GR (0.59) was superior to Fat C (0.29) as a predictor of overall fat weight.

Factor Model

Multicollinearity arises between variables when they exhibit high degrees of correlation. This is a common problem in data sets that include biological variables, such as muscle, bone and fat percentages that accumulate in predictable proportions. When a model is estimated with correlated variables, the result is that predictors of the explanatory variables become inefficient; however, they remain unbiased in large samples (Mittelhammer, 1996). One method to minimise this problem is to use factor analysis in which highly correlated variables are transformed into new variables called factors. The use of factor analysis is appropriate for this research due to the relatively small sample size. A factor analysis relies on an orthogonal transformation of the correlated variables so that new independent variables are formed. The resulting factors have zero means and a standard deviation of one but, more importantly, the correlation between the new variables (factors) approaches zero.

The factors can then be used in regression equations as independent explanatory variables, which may improve modelling efficiency.

Eigen Values

Eigen values show the proportion of total variation that is explained by each factor. These are shown in Table 2. The first three factors account for approximately 80 per cent of the total variation. The last 8 factors account for the remaining 19.52 per cent of the variation. A Likelihood Ratio Test (Chi-Square, 55df, 5136) rejects the null hypothesis of no common factors with a probability of >0.0001. This result enables us to conclude that more than one factor is appropriate for this data set. Both Akaike's Information Criterion (Akaike, 1981) and Schwarz's Bayesian Criterion (Schwarz, 1978) were minimised at 7.415 and 39.228 respectively at the five-factor level, which indicates that the upper number of factors was five. When five factors were used the last two factors were trivial. Hence, the N-Factor criterion (SAS, 2006) was used to select three factors to include in the subsequent hedonic regression.

Table 2 Eigen values

Factors	Eigenvalue	Difference	Proportion	Cumulative
1	**5.309131**	**2.465759**	**0.4826**	**0.4826**
2	**2.843373**	**2.142814**	**0.2585**	**0.7411**
3	**0.700558**	**0.175473**	**0.0637**	**0.8048**
4	0.525085	0.091888	0.0477	0.8526
5	0.433198	0.035521	0.0394	0.8919
6	0.397677	0.157912	0.0362	0.9281
7	0.239765	0.028288	0.0218	0.9499
8	0.211477	0.052885	0.0192	0.9691
9	0.158593	0.009026	0.0144	0.9835
10	0.149567	0.117991	0.0136	0.9971
11	0.031576		0.0029	1.0000

Factor Scores

The variable scores for the first three factors are shown in Table 3. From that table the variables for fat distribution (FD), fat level (FL), meat colour (MC), conformation of the hind (CH), loin (CL), and forequarter (CF), plus the predicted yield score, each load highly on factor 1. The main contributors to factor 2 are fat score (GR) and fat weight (FWT). The third factor is dominated by carcass weight (CWT) and muscle weight (MWT). From these results we form the opinion that fat distribution and level, conformation, and meat colour together represent one discreet dimension and collectively these may be termed appearance variables. GR fat score and fat weight have loaded on the second factor and these are important fat content predictors. Similarly carcass weight and muscle weight are lean meat content predictors that determine retail yield and these loaded on factor 3.

Table 3   Factor scores by variable

Variable	Description	Factor 1	Factor 2	Factor 3
FD	Fat Distribution	**0.8798**	0.0535	0.0234
FL	Fat Level	**0.8395**	0.1948	-0.0287
MC	Meat Colour	**0.7971**	-0.0048	-0.0554
CH	Conformation Hind	**0.8495**	-0.0535	-0.0155
CL	Conformation Loin	**0.9197**	0.0007	0.0384
CF	Conformation Forequarter	**0.8918**	0.0236	0.0550
Y	Predicted Yield	**0.8936**	0.0147	0.0128
CWT	Carcass Weight	0.0337	0.5737	**0.7944**
GR	GR Fat Score	0.0356	**0.8152**	0.2694
MWT	Muscle Weight	-0.0210	0.2436	**0.9615**
FWT	Fat Weight	0.0414	**0.8960**	0.1871

Hedonic Model

Hedonic models are used to estimate values for attributes of products. Waugh (1928) first applied the model to value attributes of vegetables. Other researchers such as Rosen (1974) and Ladd and Suvannunt (1976) further refined the technique. The hedonic function is similar to the utility function where its first derivative provides the demand function and as such the general form of the function should in theory be non-linear. Non-linear hedonic models have been used to estimate carcass characteristics for beef in Japan (Lin and Mori 1991; Wahl, Shi and Mittelhammer, 1995). McConnell and Strand (2000) recently applied a linear hedonic model to value attributes of tuna fish. Farrell, McCluskey, Busboom and Wahl (2005) used factor analysis in conjunction with a log-linear hedonic model to estimate sensory attributes for retail beef cuts. In general the form of the hedonic equation is as follows,

$$P = f(Z_i) + e_i \qquad (1)$$

where the price P is a vector of unit prices and Z_i is a matrix of i uncorrelated attribute variables and e_i are the standard error terms.

The model used by Farrell *et al* (2005) modifies the typical model by adding factor scores to the equation,

$$\text{Log Price} = f(F_i, Z_i) + e_i \qquad (2)$$

where F_i is a matrix of independent factor scores, Z_i are other independent variables and e_i are the error terms.

The model used for this analysis has the following form,

$$\text{Log Price} = a + b_1F1 + b_2F2 + b_3F3 + e_i \qquad (3)$$

where the cents per kilogram price nominated by the retailer or wholesaler is equal to the sum of the three factor vectors (F1, F2, F3) derived above and their coefficients b_i, plus the intercept a and the error terms e_i. The results of this regression are shown in Table 4.

Table 4 Regression results for the hedonic equation

		Parameter	Standard		
Variable	DF	Estimate	Error	t-value	Pr > |t|
Intercept	1	5.75714	0.00503	1143.64	<.0001
Appearance	1	-0.05134	0.00588	-8.73	<.0001
Fat (GR)	1	-0.00637	0.00503	-1.27	0.2055
Yield	1	-0.01252	0.00500	-2.51	0.0125

The signs on the parameter estimates were expected to be negative for Appearance and Fat and indeterminate for yield. That is, for Appearance we would expect prices to increase when the fat distribution, conformation and meat colour scores decrease (1=very good, 5= very poor). Similarly the price should increase as the amount of fat decreases. The issue with lean muscle weight (Yield) was that we expected prices to rise with carcass weight to some level slightly above twenty kilograms; however, we expected price to fall at some higher weight level. This expectation was tested with a quadratic term that produced an inferior model based on the F-value. The average carcass weight for these animals was 26 kilograms and this produced an overall negative price response.

The F-value for this regression was 28.33 with a <0.0001 probability of being greater than the F-value. Similarly the t-values were significant for Appearance and Yield at the 98 per cent level. The t-value for Fat was not significant at the 90 per cent level.

Price Elasticities

Price elasticities were calculated from the coefficients for each factor in the hedonic equation. They show the change in price that would result from a one per cent change in the variable of interest (often referred to as price flexibilities). The elasticity equation for a log-linear function where the variables had a zero mean was,

$$\eta p_i = (\text{Exponential } b_i) - 1 \qquad (4)$$

The price elasticities for the three factors are shown in Table 5.

Table 5 Price elasticities for the three factors

Factor	Elasticity	Hedonic Value c/kg
Appearance	-0.05004	-16.0142
Fat (GR)	-0.00635	-2.03192
Yield	-0.01244	-3.98142

The results in Table 5 reveal that visual attributes (factor 1) are four times more important than yield attributes (factor 3). The hedonic value for Appearance indicates that a one per cent decrease in the conformation score, fat distribution score or colour score would result in an additional sixteen cents per kilogram. Similarly a one per cent decrease in carcass weight from the mean of 26 kilograms would result in a four-cent per kilogram rise in carcass value as shown by the hedonic value for Yield. The hedonic value on Fat indicates that a one per cent reduction in the amount of GR fat and fat weight would increase price by two cents per kilogram. These results imply that appearance variables are much more important relative to fat and yield when developing an independent carcass grading system.

Discussion

The EUROP grading system did not correlate highly with other grading type variables nor any of those analysed in this research. This may have been due to the inexperience of the participants in using the EUROP system as it was not used commercially in Australia.

Drennan, Keane and Nolan (2006) report a correlation of 0.82 between mechanical conformation scores and carcass value, and a correlation of 0.79 between visual conformation scores and carcase value (data were obtained on a 15 point EUROP scoring system for carcasses from 134 two year old steers). Their results support the above conclusion that conformation is an important determinant of carcass value and that it should be included in a carcass grading system.

Meat purchasing behaviour governs the messages that are transmitted to retailers regarding meat products offered for sale. Erickson, Wahl, Jussaume and Shi (1998) report findings by Menkhaus *et al* (1993) which list cholesterol, calorie content, artificial ingredients, convenience, store display, and cost as variables that have an impact on consumer perception of meat quality. It is important to put issues of muscle shape and therefore carcass conformation into perspective against these other attributes or services to identify the value of muscle shape to consumers to ensure that retailers are interpreting the product signals of their consumers correctly (Thonney, Perry, Armbruster, Beermann and Fox, 1991).

This study indicates that development of a standard conformation scoring system should be the first priority when developing an automated grading scheme for carcasses.

Further Research

Further research on conformation values needs to be conducted to determine the average value at the wholesale and retail levels. This should include research with supermarkets and food service establishments. If conformation is as important to retailers as this research suggests then it is vital to assess which aspects of conformation are important to consumers. This would require research on the acceptability of muscles with different shapes and sizes. The research would need to be conducted on traditional products as well as boneless products.

The results presented in this paper apply to Australian domestic retailers. No research has been identified that attempts to quantify the value of conformation for lamb exporters.

In the event that conformation is confirmed to be an important descriptor of lamb then a study would need to be conducted to identify a mechanism other than genotype, eye muscle area, or Fat C to assess live animals for the attribute prior to slaughter. Saleyard operators may need to fund that research on behalf of their selling agents, as there are several devices to score carcasses for this trait for over-the-hook trading.

The correlation between lean meat yield and GR needs to be researched further. Hopkins (1994) produced regressions between carcass weight, GR and loin depth for Poll Dorset, Suffolk and Wiltshire Horn lambs with corresponding mean weights of 16.2, 14.7 and 15.7 kilograms with 11.1, 9.6, 11.9 mm respectively at the GR site. These regressions produced R-Squares of between 0.84 – 0.92. This result indicates that for low carcass weights GR and loin depth are good indicators of lean meat yield. The data reported in this study produced poor correlations (0.59) between GR and fat weight when the carcass weights increased to a mean of 26 kilograms.

Conclusion

This research supports earlier conclusions by Hopkins (1995a) who has shown that lamb conformation was the most important attribute for retailers and wholesalers. Retailers and wholesalers in this study valued a one per cent improvement in conformation at 16 cents per kilogram (c/kg).

Carcass weight and lean muscle weight were important to retailers and wholesalers who valued the trait at 4 c/kg for a one-unit in yield. The least significant trait was the combination of GR and fat weight where the assessors valued this trait at 2 c/kg for a one per cent change in the fat levels.

The value of muscle and cut shape need to be validated at the consumer-retailer interface to ensure that retailers are correctly interpreting consumer signals that they prefer cuts derived from animals with better conformation. That research would need to be undertaken with an average group of retailers and supermarket companies using both traditional cuts and boneless cuts to confirm the values estimated above.

Bibliography

Akaike, H. (1981) Likelihood of a model and information criteria. *Journal of Econometrics*, Vol. 16, pp.3-14.

Drennan, M.J., Keane, M.G. and Nolan, M. (2006) Relationship of carcass grades with carcass composition and values of steers, paper presented to the EAAP meetings Antalya, 17th September.

de Boer, H. (1992) EC Standard carcass classification in Europe; history and actual position. *Meat Focus International*, Vol. 1, pp. 365-368.

Erikson, G.R., Wahl, T.I., Jussaume, R.A. and Shi, H. (1998) Product characteristics affecting consumers' fresh beef purchasing decisions in the United States, Japan and Australia, *Journal of Food Distribution Research*, November, pp.16-25.

Fogarty, N.M., Hopkins, D.L. and van de Ven, R. (2000). Lamb production from diverse genotypes. 2. Carcass characteristics. *Animal Science* Vol. 70, pp. 147-156.

Farrell, T.C., McCluskey, J.J., Busboom, J.R. and Wahl, T.I. (2005) A hedonic model for correlated sensory attributes of retail beef cuts, working paper, Washington State University.

Freebairn, J.W. (1973) The value of information provided by a uniform grading system, *Australian Journal of Agricultural Economics*, Aug, pp. 127-139.

Hopkins, D.L. (1994) Predicting the weight of lean meat in lamb carcasses and the suitability of this characteristic as a basis for valuing carcasses, *Meat Science*, Vol. 38, pp. 235-241.

Hopkins, D.L. (1995a) Understanding the factors wholesalers and retailers use to value lamb carcasses. CSIRO Meat Industry Research Conference, MEAT 95.

Hopkins, D.L (1995b) Shape and size considerations for boneless lamb cuts. *Meat Focus International*, November, pp. 445-447.

Hopkins, D.L. and Fogarty, N.M. (1998). Diverse lamb genotypes- 1. Yield of saleable cuts and meat in the carcass and the prediction of yield. *Meat Science* Vol 49, pp. 459-475.

Hopkins, D.L., Hayhurst, G. and Horcicka, J.V. (1992) Computer programs which enable pricing of sheep and lamb carcasses based on yield estimation, suitability and financial parameters, *Asian Australasian Journal of Animal Sciences,* Vol.5, No.1, pp.1-5.

Hopkins, D.L., Wotton, J.S.A., Gambel, D.J. and Atkinson, W.R. (1995) Lamb carcass characteristics 2. Estimation of the percentage of saleable cuts for carcasses prepared as 'trim' and traditional cuts using carcass weight, fat depth, eye muscle area, sex and conformation score, *Australian Journal of Experimental Agriculture*, Vol. 35, pp 161-169.

Ladd, G.W. and Suvannunt, V. (1976) A model of consumer goods characteristics, *American Journal of Agricultural Economics*, Vol. 58, pp. 504-510.

Lin, Bing Hwan and Mori, H. (1991) Implicit values of beef carcass characteristics in Japan: implications for the US beef export industry, *Agribusiness*, Vol. 7, No. 2, pp. 101-114.

McConnell, K.E. and Strand, I.E. (2000) Hedonic prices for fish: tuna prices in Hawaii, *American Journal of Agricultural Economics*, Vol. 82, No. 1, pp. 133-144.

Mittelhammer, R.C. (1996) *Mathematical Statistics for Economics and Business*, Springer-Verlag, New York, pp. 377-383.

Mullen, J.D. and Wohlgenant, M.K. (1991) The willingness of consumers to pay for attributes of lamb, *Australian Journal of Agricultural Economics*, Vol. 35, No. 3, pp. 247-262.

National Livestock Reporting Service (2007) NSW lamb market report for the week ending Thursday 18th February.

O'Halloran, W.J. (1991) Marketing of Sheep and Sheepmeats in D. Cottle (Ed.) *Australian Sheep and Wool Handbook*, Inkata Press, Melbourne, pp. 349-366.

Schwarz, G. (1978) Estimating the dimension of a model. *The Annals of Statistics*, Vol. 6, pp. 461-464.

Sporleder, T.L. (1972) Frozen lamb: consumer product characteristic ratings and Repeat Purchase Behaviour, *Journal of Food Distribution Research*, September, pp. 10-15.

Wahl, T.I., Shi, H. and Mittelhammer, R.C. (1995) A hedonic price analysis of quality characteristics of Japanese Wagyu beef, *Agribusiness*, Vol.11, No.1, pp. 35-44.

Waugh, F. (1928) Quality factors influencing vegetable prices, *Journal of Farm Economics*, Vol. 10, pp. 185-196.

Appendix 1. Correlation matrix for input variables.

Description		FD	FL	MC	CH	CL	CF	Y	CWT	GR	MWT	FWT
Fat Distribution	FD	1	**0.76710**	0.48225	0.56395	**0.72333**	**0.66821**	**0.67988**	0.09212	0.09581	0.03672	0.09778
Fat Level	FL	**0.76710**	1	0.51403	0.45404	**0.6571**	**0.61592**	**0.68048**	0.14098	0.16849	0.03655	0.19869
Meat Colour	MC	0.48225	0.51403	1	**0.61343**	0.56701	0.48951	0.53828	0.01312	-0.00418	-0.05891	0.07026
Conformation Hind	CH	0.56395	0.45404	**0.61343**	1	**0.71048**	**0.65791**	**0.64436**	0.00168	0.01241	-0.05864	0.03361
Conformation Loin	CL	**0.72333**	**0.6571**	0.56701	**0.71048**	1	**0.78544**	**0.75218**	0.06963	0.07343	0.01716	0.07360
Conformation Forequarter	CF	**0.66821**	**0.61592**	0.48951	**0.65791**	**0.78544**	1	**0.72695**	0.10741	0.07742	0.03447	0.11951
Predicted Yield	Y	**0.67988**	**0.68048**	0.53828	**0.64436**	**0.75218**	**0.72695**	1	0.05601	0.04748	0.00533	0.09031
Carcass Weight	CWT	0.09212	0.14098	0.01312	0.00168	0.06963	0.10741	0.05601	1	**0.60782**	**0.88294**	**0.70566**
Fat Score	GR	0.09581	0.16849	-0.00418	0.01241	0.07343	0.07742	0.04748	**0.60782**	1	0.47035	0.59221
Muscle Weight	MWT	0.03672	0.03655	-0.05891	-0.05864	0.01716	0.03447	0.00533	**0.88294**	0.47035	1	0.37441
Fat Weight	FWT	0.09778	0.19869	0.07026	0.03361	0.07360	0.11951	0.09031	**0.70566**	0.59221	0.37441	1

---

[1] Paper presented to the 51st annual conference of the Australian Agricultural and Resource Economics Society, 13-16 February 2007, Queenstown, New Zealand.