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Prepared by: A.B. Pleasants
AgResearch

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Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Towards the development of a next generation MSA lamb model – statistical support

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Abstract

This work developed the analyses relating consumer judgements of sheep meat eating quality for the Loin and Topside to sire effects for genetic improvement. A discriminant function related the attributes of the sensory variables, tenderness, juiciness, flavour and overall liking to consumer judgement of eating excellence. Variation in this function described sire differences for effects due to year, sire breed, processing site and consumer's variation, and was related to eating quality. Consumer judgements using different reference criteria resulted in difficult frequency distributions. This was alleviated by weighting each observation by consumer variances for each of the sensory variables to calculate sire intra-class correlations. A function relating carcass attributes to consumer eating quality through a discriminant function was developed and related to sire differences for genetic improvement.

Executive Summary

This work was carried out to relate consumer judgement of sheep meat eating quality to differences between sires, and to develop a method for discriminating meat cuts of different eating quality for the retail sector.

Sheep meat eating quality and the sensory attributes of tenderness, juiciness, flavour and overall liking was evaluated by a large number of consumers for meat from the loin and topside cuts. The meat evaluated was classified within 2 production years, 2 dam types (Merino and non – Merino) 14 sire breeds including 185 different sires, 16 kill groups, 5,640 consumers in 94 consumer sessions (pick). Each consumer judged 6 randomly selected meat samples.

The statistical analysis identified significant fixed effects due to year and sire breed, and random effects due to sire within sire breed within kill group, and consumer within consumer group. Meat from sires of the Dorset and Texel breeds produced poorer eating quality meat than sires from the Merino breed. However, there was also significant between sire variations, with a number of sires from breeds giving poorer average eating quality being highly ranked overall for the eating quality of meat from their progeny.

The consumer judged classification of sheep meat eating quality into one of 4 grades (star 2 – poor to star 5 – excellent) was linked to consumer evaluation of the 4 sensory variables through both a linear discriminant analysis and a multinomial logit analysis. Both provided the same answer, but emphasised different attributes of value for the wider analysis. The best linear discriminant function would incorrectly classified 17% of the star 4 Loin cuts as star 5 and 19% of the Loin cuts as star 3. Similarly 32% of the star 5 Loin cuts would be miss classified to a lower star rating.

It was noted that the frequency distribution for consumer evaluations of eating quality and values of the sensory variables exhibited characteristics associated with individual consumers having different reference points for assessing these attributes. Tests of association showed that individual consumers maintained a consistent reference point during their judgements, however there was notable variation in the value of reference points between consumers. This resulted in frequency distributions for the consumer judged variables that were skewed to the right or to the left depending on the average value of the variable of interest. The problem had been noted in other studies of beef eating quality, and was dealt with in these cases by “clipping” the data – i.e. removing extreme values from the analysis.It was considered that this issue was a natural feature of the meat eating population, and not due to “rogue” consumers. Careful handling of the meat for testing ruled out major variation in eating quality due to cooking or preparation.

A remedy for this problem was developed by weighting the data according to the frequency of each reference point. This avoids over emphasis on the results from consumers whose reference points are “unusual.

The score for each meat sample provided by the optimal linear discriminant function could be analysed for sire breed and sire within sire breed effects for this trait. Using an analysis weighted by the principal component described above the sire intra-class correlation was 0.38 for the loin cut. The un-weighted sire intra class correlation was 0.06. Sire BLUP values were calculated and presented for each sensory variable, the eating quality score and the optimal discriminant function. Clipping the data also improved

estimates of the intra – class correlations, although at the cost of removing 30% to 40% of the data. Weighting by the inverse of the variances includes all the data in the calculation.

A program for genetic improvement of sheep meat eating quality must depend on traits that can be measured in the supply chain. In particular these supply chain traits are expected to be intramuscular fat, hot carcass weight, C site fatness and/or GR tissue depth and eye muscle area. The success of an improvement program will depend on how well these traits determine the eating quality. Since the discriminant function relates the sensory variables affected by these carcass traits to consumer judged eating quality in an optimal way, the relationship between these carcass traits and the discriminant function is of importance in defining an improvement program. This relationship is calculated, and a probabilistic model constructed to link measurements of these carcass traits to variation in eating quality as mediated through the linear discriminant functions.

The conditional probability distribution for the eating quality score given the measurements of the carcass variables intra – muscular fat and shear force is then:

$$P[EQ|IMF; SHEARF5] = P[EQ|dis] \times P[dis|IMF; SHEARF5]$$

Where $P[EQ|dis]$ = Multinomial distribution

$P[dis|IMF; SHEARF5]$ = beta distribution

This formulation can be applied to derive a conditional multinomial probability distribution for the consumer evaluated eating quality score given expected values for intra – muscular fat and shear force.

It was shown that intramuscular fat and shear force 5 sire BLUP values are not related to the discriminant function sire BLUP values, suggesting that these aspects of meat quality are not related to sire differences. CEMA, the fat measurements and LMY are moderately correlated indicating sire differences in discriminating sheep meat eating quality are associated with these variables. There was a significant ($P < 0.02$) relationship between the sire BLUP for the amount of intramuscular fat in a loin cut and the sire BLUP for the probability (frequency) with which that cut would be graded as high eating quality (star 4 or star 5). The correlation was $r = 0.15$. However, though the relationship was significant the predictability was low.

There will be direct industry benefit from this work through the formulation of the discriminant model relating tenderness, juiciness, flavour and overall liking to environmental variables and differences between sires. This is the basis for a successful breeding scheme targeting sheep meat eating quality. In addition, the identification of supply chain variables affecting eating quality is the basis for a program to improve this trait. The benefit is to industry, the retail sector and the consumer in an improved, better described, product.

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Background

The current MSA lamb and sheepmeats model is a pathways approach and is basically an 'in' or 'out' system applicable to all prime lamb production. The system has either been formally or informally adopted widely across Australia. The MSA system is still appropriate for underpinning the quality of lamb carcasses. However, it will date rapidly as adoption builds and the need to differentiate specific cuts becomes apparent.

A new model for continuous improvement incorporating eating quality management and genetics is seen as crucial for the future underpinning of lamb demand domestically.

There are 3 key drivers that influence demand for lamb (1) lean meat yield (that is consumers do not want fat), (2) eating quality and (3) nutritional attributes from a human perspective – these all drive purchases, willingness to pay decisions and consumer satisfaction. Lean meat yield is also a key productivity driver throughout the supply chain, and has rapidly increased in the last 10 years as lambs have become larger, leaner and more muscular. These features will still be a factor in the future, and accordingly an important feature of the next generation MSA lamb proposal is to secure the eating quality and nutritional attributes of the product against detrimental changes that will take place if there was a single trait focus on lean meat yield without consideration of eating quality.

The data from the Sheep CRC information nucleus flocks has shown that the carcass (muscle, fat, weight, lean meat yield) and objective eating quality phenotypes (intramuscular fat, shear force) are moderate to highly heritable. In addition there are significant and unfavourable correlations between lean meat yield and the eating quality measures. This important background information has especially highlighted intramuscular fat as a key trait to manage.

Given this background the next critical stage is to test lamb cuts through the MSA consumer protocols and the true eating quality can be determined and finally related to the objective measures undertaken on the information nucleus animals. Two cuts (loin and topside) from 745 2009 drop lambs derived from 97 sires were tested using the grill protocol in 2010 and the early analysis shows a significant effect of sire on the eating quality of both cuts. The range in eating quality score for Overall Liking was 10 points for both cuts. In terms of rating (i.e. unsatisfactory, 3, 4, 5 star) this likely means that soime sires produce a topside that at best is just a 3 star, while others produce a product close to 4 star. For the loin it means product ranging from 4 to 5 star.In terms of breed there is a trend for lambs sired by Merinos to produce higher eating quality cuts than those sired by terminals. This needs further exploration.

The same consumer research has shown that consumers are prepared to pay twice as much for '3' compared to '2' star; 3 times as much for '4' compared to '2' star; and 5 times as much for '5' compared to '2' star.

The Sheep CRC has been commissioned to test another round of approximately 115 sires (including the Dorper breed for the first time) from the Information Nucleus flock in 2011. Additional testing of hogget Merinos has also been approved. This project deals with the statistical analyses of this data.

Project Objectives

Task 1.

1. Develop an ASRemel statistical model that predicts the influence of sire on tenderness, juiciness, flavour and overall liking, composite eating quality score and finally rating ((i.e. 2, 3, 4, 5 star). This model is to use all 10 answers per cut and would include a number of fixed effects, covariates and random terms. Further statistical modelling described in the tasks below must relate to this base sire ASRemel model.
2. Develop the best balance of tenderness, juiciness, flavour and overall liking to predict the final rating (i.e.2, 3, 4, 5 star). Previously overall liking has been found as the best predictor – however, compare this with a mixture of all 4 when overall liking is held at 0.4 (i.e. analogous to the beef MSA). Also contrast these weightings for the two cuts and potentially how they differ across breeds.
3. Test thehypothesis that tenderness is a key discriminator in this data set and that flavour moderates this discrimination, i.e. people that will tolerate tougher lamb because they like the flavour.
4. Develop cut off scores between 2/3, ¾, 4/5 stars
    - Initially using discriminant analysis or another appropriate method.
    - Taylor these cut – offs (push up or down) so as sire variation in eating quality fails around these cut – offs
    - Clearly quantitate the implication for consumer satisfaction of the different cut – off scores, i.e. at any given cut – off say ‘4’ v ‘5’ star the probability that a consumer will rate the meat as ‘2’, ‘3’, ‘4’ or ‘5’ star.
    - Assist with the detailed genetic analyses to determine the relationships between objective measures of eating quality (intramuscular fat, shear force, pHu) and lean meat yield (HCW, fatness, muscling) with consumer based eating quality.

Task 2

Repeat task 1 except this time use the 2011 and 2010 eating quality data sets (Sheep CRC Information Nucleus from the 2009 and 2010 drop lambs).

Methodology

Milestone 1

Data was supplied by MLA and the Sheep CRC on the eating quality of sheep meat as judged by a number of consumers tasting meat samples arranged into groups called “picks”. Each consumer tasted 6 meat with samples taken from a cut of lamb (Loin or Topside) of different lambs. Each lamb cut (i.e. topside or loin) was tasted by 10 consumers in a balanced Latin square design (Thompson et al. 2005; Watson et al. 2008).

Different cohorts of 10 consumers made up different picks (a pick is a tasting session where 36 cuts are tested by 60 consumers). The consumers rated each sample on a scale from 1 to 100 for smell, tenderness, juiciness, flavour and overall liking. In addition each sample was rated according to a star classification were star 1 was poor eating quality and star 5 was excellent eating quality. A general satisfaction score were also recorded which will be analysed by Dr. Pannier.

The lamb meats tested were also classified by a number of carcass measurements as well as by flock, kill group, sire breed, dam breed, sex, birth rank and sire. Each Kill Group was nested within flock, so that each flock comprised a distinct set of Kill Groups, and sires were nested within sire breeds within Kill Groups. As noted above consumers were nested within picks. This classification defined the linear mixed model for the analysis which included all significant ($P < 0.05$) effects

$$y = \mu + sire\ breed + Kill\ Group + sire\ within\ sire\ breed\ within\ Kill\ Group + consumer\ within\ pick + error \qquad (1)$$

Each cut (Loin and Topside) was analysed separately. An earlier analysis found that the variance components for sire within sire breed within Kill group were significantly different. The model was analysed using REML to obtain the variance components, the BLUP estimates for the sires and the means for the fixed effects. The multiple comparisons of the fixed effects were performed using Tukey’s HSD test, which makes adjustments to take account of the number of comparisons being made. This was important given that there were 12 sire breeds being tested with the potential to give misleading levels of significance when based on the individual t values.

The star classification of meat eating quality was a categorical variable, and analysed as a generalised linear model using the logit transformation. In this case each ordered star rating was tested against adjacent star ratings. Thus, star 4 was compared with star 5, star 3 was compared with star 4 etc.

Using the above model as a basis, a number of carcass attributes referred to as the covariates (carcass weight, age, fat, intra – muscular fat, pH and shear force) were tested for any relationship with the eating quality variables, smell, tender, juicy, flavour, overall liking and star classification. All significant covariates were included in the final analysis.

The data was analysed using the lme4 statistical package in R, with multiple comparisons among the sire breed effects tested with the Tukey’s HSD method implemented in the ‘multcomp’ R package. The significance of variance components was tested using the likelihood ratio test.

Milestone 2

Statistical Discriminant Analysis was applied to find the optimum combination of the scores for eating quality (EQ) variables, tender, juicy, flavour and overall liking that partitioned a meat sample into one of the star ratings. Linear discriminant analysis was sufficient for meat cuts from the Loin, but quadratic discriminant analysis was necessary to deal with meat cuts from the Topside.

In addition multinomial logit functions were calculated for star categories 2 to 5. Using the Logit function is considered to be superior to discriminant analysis as it relies on fewer assumptions. Using the Logit analysis it is straightforward to test for a relationship between tender and flavour which moderates the influence of tenderness, by examining the interaction terms for these variables.

The dominance of Overall Liking in affecting the discrimination procedure was examined. Dividing the Overall Liking score by a factor of 0.35 will force the discriminant coefficient for Overall Liking in the discriminant function to be 40% of the sum of the coefficients in this function, but this had no effect on the accuracy of allocation of meat cuts to star categories. There were 2 other strategies investigated that sought to deemphasise the role of Overall Liking in the discrimination. One was to remove all variation in Overall Liking associated with the other EQ variables, tender, juicy and flavour. Then to include only the remaining Overall Liking residuals in the discriminant function. The second strategy was to reduce the variation in Overall Liking by rounding the Overall Liking scores to the nearest 10. For example, variation might be reduced by rounding up the scores, thus making an EQ score of 62 equal to a score of 60, and an EQ score of 77 equal to a score of 80.

It was noted in the report for Milestone 1 of this project that consumer scores for the EQ variables did not appear to be following a common scale. That is, some consumers were more stringent in what they considered as excellence than others. For example, one consumer has a lower threshold than another consumer to attribute excellence to a meat sample. This issue could cause problems if consumers also changed their evaluation scales between each of the EQ variables. It was necessary to examine this problem to see if there was an identifiable subset of consumers that need to be treated separately.

Milestone 3

The earlier milestones applied discriminant analysis to find a function of the EQ variables tenderness, juiciness, flavour and overall liking that best predicted the eating quality score (expressed as a star rating 2 = poor, 5 = excellent). Data with a star rating of 1 was excluded. A discrimination based on a multivariate logit analysis was considered to be most appropriate, although a function based on classical discriminant analysis was also satisfactory.

The discriminant function of the sensory variables (tenderness, juiciness, flavour and overall liking) showed a poor relationship to differences among sires, in the sense of having a low intra – class correlation (< 0.1). To remedy this, a linear function that better ranked sires and which might be the basis for a genetic selection program was sought. Each of the sensory variables was analysed for each cut (loin or topside) for all the factors in the model except sire within sire breed within kill group, and the residuals calculated. Using the set of residuals for the sensory variables a canonical correlation with the sires was calculated for each cut.

The canonical correlation finds the linear function of the sensory variables that maximises the correlation with the variation among sires.

The linear function of the sensory variables defining the canonical correlation between the sire and the sensory variables (tenderness, juiciness, flavour) was used to calculate a number characterising the ensemble of sensory variables. This was then used in the full model to find the intra – class correlation coefficient for sires within sire breed within kill group. Modification of the weights of this new (canonical) discriminant function was carried out to maximise the sire intra – class correlation coefficient. The result of this procedure was the definition of a new candidate discriminant function for consumer eating quality that was maximally related to variation among the sires. This new discriminant function, although not optimal for discriminating among consumer star ratings based on the sensory variables, did discriminant better among sires and could be tested for accuracy of prediction using discriminant analysis procedures.

A further approach to identifying a relationship between sires and sheep meat eating quality was to select a subset of the data by eliminating observations with residuals that exceeded a certain absolute deviation. This amounts to redefining the population of interest to be a subset more closely gathered about the mean. It defines a population that is much more homogeneous and makes inferences about this population, particularly about the relationships of sires and eating quality within this subpopulation. The question is whether inferences based on this restricted redefined population of consumers had relevance to the unrestricted population of consumers. In terms of the selection of sires for genetic improvement of sheep meat eating quality it is possible that this is the case, though it remains to be determined objectively.

The relationship between overall liking and the other sensory variables (tenderness, juiciness' and flavour) has become an issue. In particular, the question of the extra attributes of sheep meat eating quality detected by the consumer that are not covered by variation in the other 3 sensory variables. This question could be addressed by regressing overall liking on the other sensory variables and using the residuals calculated from this regression to test for significant relationships with other variables of interest.

The question of the scope for genetic improvement of sheep meat eating quality depends on the relationship between the progeny of different sires and eating quality attributes. This issue was examined by calculating the Best Linear Unbiased Predictors (BLUP) of the sires for the optimal linear discriminant function and various carcass attributes measured on the progeny. The relationship of these carcass attributes (intra – muscular fat, eye muscle area, GR fat, shear – force) to the sires BLUP's of the linear discriminant function provided an estimate of how selection based on these variables related to the consumer judgement of sheep meat eating quality. A second calculation based of the sire breeding values of post weaning growth rate, post weaning eye muscle area and post weaning fat related these variables to the sire components of the discriminant function for eating quality.

Because the work in establishing these results required investigation time (resulting in a number of blind alleys) only the genetic analysis results for the Loin cut are reported in this interim report. The Topside cut will be addressed in the Final report. Because results suggested that there was a stronger relationship between eating quality judgements in the

Loin rather than the Topside cut it is likely that decisions about genetic selection would be optimally based on the Loin cut alone

Milestones 4 and 5

Data was supplied by MLA and the Sheep CRC on the eating quality of sheep meat as judged by a number of consumers tasting meat samples arranged into groups called “picks”. Each consumer tasted 6 meat samples with these samples taken from a cut (Loin or Topside) of different lambs. Each lamb cut (i.e. topside or loin) was tasted by 10 consumers in a balanced Latin square design (Thompson et al. 2005; Watson et al. 2008).

Different cohorts of 10 consumers made up different picks (a pick is a tasting session where 36 cuts are tested by 60 consumers). The consumers rated each sample on a scale from 1 to 100 for smell, tenderness, juiciness, flavour and overall liking. In addition each sample was rated according to a star classification were star 1 was poor eating quality and star 5 was excellent eating quality. A general satisfaction score were also recorded which will be analysed by Dr. Pannier.

In the earlier analyses for drop 2010 the lamb meats tested were also classified by a number of carcass measurements as well as by flock, kill group, sire breed, dam breed, sex, birth rank and sire. Each Kill Group was nested within flock, so that each flock comprised a distinct set of Kill Groups, and sires were nested within sire breeds within Kill Groups. As noted above consumers were nested within picks.

In drop 2010 a different group of sires compared with drop 2009 were recorded, and grouped into different kill groups. Because some sires only had the results from male progeny recorded only male progeny were used in the analyses to make comparisons valid.

This classification defined the linear mixed model for the analysis which included all significant ($P < 0.05$) effects. The difference from drop2009 model is that kill group is now treated as a random variable given the large number of available kill group sites. It is arguable that this variable should always have been treated as random not fixed. With the combined years and the increased number of different kill groups this classification becomes feasible. Consumer and pick are also treated as random variables. The model is

$$y = \mu + year + sire\ breed + sire\ within\ sire\ breed\ within\ kill\ Group\ within\ year \\ + consumer\ within\ pick + error$$

Each cut (Loin and Topside) was analysed separately. The model was analysed with the Lme4 package of “R” using REML to obtain the variance components, the BLUP estimates for the sires and the means for the fixed effects. The multiple comparisons of the fixed effects were performed with the “R” package GLHT using Tukey’s HSD test, which makes adjustments to take account of the number of comparisons being made. This was important given that there were 12 sire breeds being tested with the potential to give misleading levels of significance when based on the individual t values due to the scope for spurious comparisons..

The star classification of meat eating quality was a categorical variable, and analysed as a generalised linear model using the logit transformation. There were 2 comparisons between the categorical variable star rating. One comparison was the probability of being in star groups 2 or 3 *versus* the probability of being in stars 4 or 5. The second comparison was of the probability of being in star 4 *versus* the probability of being in star 5. The probabilities were calculated from the logits in the usual manner.

Using the above model as a basis, a number of carcass attributes referred to as the covariates (carcass weight, age, fat, intra – muscular fat, pH and shear force) were tested for any relationship with the eating quality variables, smell, tender, juicy, flavour, overall liking and star classification. All significant covariates were included in the final analysis.

The data was analysed using the lme4 statistical package in R Core Team (2012). R: A language and environment for statistical computing. *R [R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URLhttp://www.R-project.org/.],* with multiple comparisons among the sire breed effects tested with the Tukey's HSD method implemented in the 'multcomp' R package. The significance of variance components was tested using the likelihood ratio test.

The relationship between overall liking and the other sensory variables (tenderness, juiciness' and flavour) has become an issue. In particular, the question of the extra attributes of sheep meat eating quality detected by the consumer that are not covered by variation in the other 3 sensory variables. This question could be addressed by regressing overall liking on the other sensory variables and using the residuals calculated from this regression to test for significant relationships with other variables of interest. That is, the residuals from the regression of overall liking on the other sensory variables measures other attributes of eating quality not captured by tenderness, juiciness and flavour. The residuals were treated as a sensory variable in analyses with the goal of capturing elements of meat eating quality not associated with tenderness, juiciness and flavour, but also not confounded with these variables as overall liking obviously is.

A linear discriminant function was calculated to predict the meat quality eating classification (star rating) using discriminant analysis. The alternative method of discrimination using logits was also calculated. Both approaches give the same results, however the logit approach has the advantage of an easy calculation of the probability that a meat cut with given sensory variable attributes will perform in any given star classification.

The asymmetric nature of consumer responses noted in the analysis of the drop 2009 data and detailed in the earlier reports on this project reoccurred in drop 2010. As noted in the earlier reports these responses adversely impacted the results as the "noise" generated by this effect obscured other effects of interest. An effective remedy found in the earlier reports was to trim the data by excluding observations with evidence of consumer generated disturbance. This approach was to select a subset of the data by eliminating observations with residuals from the sensory variable overall liking that exceeded a certain absolute deviation. This amounts to redefining the population of interest to be a subset more closely gathered about the mean. It defines a population that is much more homogeneous and makes inferences about this population, particularly about the relationships of sires and eating quality within this subpopulation. The question is whether inferences based on this restricted redefined population of consumers had relevance to the unrestricted population of consumers. In terms of the selection of sires for genetic improvement of sheep meat eating quality it is possible that this is the case, though it remains to be determined objectively.

In the analysis of the 2009 data selecting observations with an absolute residual deviation of 5 overall liking units gave the best response. In this analysis with the combined years 2009 and 2010 it was found that a similar response was obtained by selecting observations with an absolute deviation of 10 overall liking units. This was more satisfactory and it encompassed a larger proportion of the population (59% for the loin; 48% for the topside).

The question of the scope for genetic improvement of sheep meat eating quality depends on the relationship between the progeny of different sires and eating quality attributes. This issue was examined by calculating the Best Linear Unbiased Predictors (BLUP) of the sires for the optimal linear discriminant function and various carcass attributes measured on the progeny. The relationship of these carcass attributes (intra – muscular fat, eye muscle area, GR fat, shear – force) to the sires BLUP's of the linear discriminant function provided an estimate of how selection based on these variables related to the consumer judgement of sheep meat eating quality. A second calculation based of the sire breeding values of post weaning growth rate, post weaning eye muscle area and post weaning fat related these variables to the sire components of the discriminant function for eating quality.

Milestone 6

Previous work in this project established the contribution of sire breeds and sires within breeds to variation in sheep meat eating quality. In particular, the role of variation in consumer appreciation of eating quality was shown to matter. The difference in consumer reference points when judging meat eating quality was a significant factor, and this factor was not symmetric in its effect across the consumer population. This resulted in skewed frequency distributions for the sensory variables tenderness, juiciness, flavour and overall liking. This skewness confounded the effects on eating quality due to sire differences, leading to low intra – class correlations, or estimates of heritability.

Earlier reports showed that this problem could be overcome by clipping the data by calculating the residuals of fitting a model including year, cut, sire breed, and sire within sire breed within Kill group, then discarding all those observations with an absolute residual greater than 5 units before reanalysis. The clipped data removed consumers with reference points far from the average consumer response and improved the symmetry of the data analysed. The sire intra – class correlations were considerably improved (details in the report on milestone 5) and it was inferred that using clipped data a breeding program to improve sheep meat eating quality was feasible.

This final milestone completes the study by linking the earlier analyses based on 10 consumers making separate evaluations of a meat cut from one sheep to single measurements of a range of carcass variables (Shear force, intra – muscular fat, carcass weight, age, pH etc.). The work by Dr Pannier that has analysed these relationships in depth also links to this final milestone.

Results

Milestone 1

The data on the EQ variables showed a tendency towards skewness. This was because regularly 1 or 2 consumers at the level of cut by consumer recorded judgments on eating quality that were dramatically different from the consensus of other consumers in the cohort. This problem has been noted in other analyses of meat eating quality where it was dealt with by 'clipping' the data – i.e. removing a proportion of the extreme observations. However, the inclusion of a term in model (1) that nested consumer within pick as a random variable accounted for these deviations and the assumptions of the analysis of variance were met (Figure 1.1). This issue will arise again in succeeding milestones of this project (see discussion).

The cuts Loin and Topside were analysed separately to aid interpretation. There was no significant effect for either cut due to the effect of the dam breed the sex, age or birth rank. Of the carcass attributes measured intra – muscular fat and shear force 5 generally showed a significant effect of the EQ variables. These effects were both included in the statistical model (1).

The fixed effect estimates and their standard errors for the EQ variables for the Loin cut are shown in Table 1.1 and for the Topside cut in Table 2.1. For ease of interpretation the multiple comparisons for significant differences among the sire breeds and the Kill Groups are presented in a separate table. The sire breed and Kill Group multiple comparisons or each of the EQ variables for the Loin cut is given in Table 3.1 and for the Topside cut in Table 4.1. It is notable that the meat eating quality for lamb meat from Poll Dorset sires were poorest while the lambs meat from Merino sires were best. Generally the sire breeds showed a consistent effect on both cut types.

The EQ variable Smell was not related to any of the independent variables in either Loin or Topside.

Higher intra – muscular fat improved the scores for all EQ variables except smell, while shear force 5 was related to decreased EQ scores. The pH18 was generally not significant. The intra – muscular fat showed a quadratic response for Juicy, Flavour and Overall Liking in the Loin cut but not in the Topside cut. The quadratic coefficient was negative indicating that the response to intra – muscular fat decreased as intra – muscular fat increased. Because the inclusion of the covariate affected the least squares estimates of the fixed effects the estimates of sire breed and Kill group are also shown without the covariates in the statistical model for comparison with other analyses.

The Kill Group 331K09 showed significant consistently poorer EQ scores than lamb meat from other Kill Groups for both Loin and Topside (Tables 3.1 and 4.1).

The analysis of the Star category variable used a generalized linear model with a binomial link function to evaluate the independent variables of model (1) and the carcass covariates. The analysis of the Star Classifications for meat quality takes into account the discrete nature of these variables. The usual approach is to analyse the logit, which are the log ratios of the probabilities (p) of being in one classification or the other

$$logit = z = log\left(\frac{p}{1-p}\right)$$

After analysis this operation can be reversed to give the frequencies of being in one classification or the other

$$p = \frac{1}{1 + e^{-x}}$$

These estimates (logit and proportion) are given in Table 5.1 for the Loins and Table 6.1 for the Topside. There were significant sire breed and Kill group differences in the proportion of samples in Star categories 1, 2, and 3 verses Star categories 4 and 5 in both cuts. There were significant sire breed and Kill group differences in Star category 3 verses Star category 5 for the Loin cut but not the Topside cut. Other comparisons for differences in the Star categories were not significant, and/or were unstable due to low numbers and the complexity of the statistical model.

Also given in Table 5.1 and Table 6.1 is an estimate of the proportion of samples in each of the category classifications to aid interpretation. For example for the Merino sire breed 60% of the meat samples were classified as Star 4 or Star 5 compared with 42% of the meat samples from the Texel sire breed.

The significant sire breed comparisons and the Kill Group comparisons for the Star 1, 2, 3 verses Star 4, 5 are shown in Table 7.1 for the Loin and Table 8.1 for the Topside.

Table 9.1 gives the variance components for the Loin cut for each of the EQ variables and Table 10.1 presents the variance components for the Topside cut. The size of the consumer variance component is remarkable in relation to the size of the pick variance component. On average the intra – class correlation for consumers is about 0.4, while that for pick is effectively zero. This suggests that an ensemble of 60 consumers in a pick is relatively stable in their judgment of eating quality, while individuals within this ensemble vary considerably. That is, the proportion of dramatic deviations commented on earlier is relatively constant within a group the size of a pick (60 people).

The sire variance components are all significant except for Smell, which showed no significant variance component. The size of the variance components for each of the EQ variables is similar, no doubt reflecting the size of the correlations between these variables.

The variance components estimated without intra – muscular fat and shear force 5 in the model are shown in brackets in Tables 9.1 and 10.1. It is notable that not accounting for these covariates improves the sizes of the variance components, but not by very much.

Table 11.1 gives the Best Linear Unbiased Predictors (BLUP) estimates for the EQ variables for each of the sires for the Loin cut, ordered by breed of sire. Table 12.1 presents the same results for the Loin cut ranked by sires for each of the EQ variables ordered from 1 to 94. The correlation coefficients between these EQ BLUP estimates are given in Table 13.1 for the Loin. The Tender variable has low correlation with the other EQ variables which are all highly correlated.

Table 14.1 gives the Best Linear Unbiased Predictors (BLUP) for each of the sires and their rank order for the Loin cut, for the comparison of Star categories 1, 2, 3 verses Star categories 4, 5.

Table 15.1 presents the Best Linear Unbiased Predictors (BLUP) for each of the sires for the Topside cut, while Table 16.1 gives the rank order for each of the sires for each of the EQ variables. Table 17.1 gives the correlations between the BLUP sire estimates for each of the EQ variables'. The correlations are all high for the Topside cut.

Table 18.1 gives the Best Linear Unbiased Predictors (BLUP) for each of the sires and their rank order for the Topside cut, for the comparison of Star categories 1, 2, 3 verses Star categories 4, 5

Table 19.1 gives the correlations between the Loin and Topside for the sire best linear unbiased predictors estimated for the Tender, Juicy, Flavor and Overall Liking. Tender and Flavour are moderately correlated (r = 0.4), while Juicy and Overall Liking are highly correlated (r = 0.6).

Tables 20.1 and 21.1 give the sire BLUP estimates for the Loin and Topside cuts respectively. Tables without the covariates of intra – muscular fat and shear force 5. Tables 22.1 and 23.1 present the sire BLUP ranks for the Loin and Topside respectively where the sire ranks with and without the covariates are listed.

Discussion Milestone 1.

The differences in Kill Group within Flock are significant and expected. It is unclear what circumstances contribute to these differences which are probably associated with practices at different meat plants. It is notable that inclusion of pH measurements of the meat did not affect these differences.

These effects are an important source of variation in the eating quality of lamb meat experienced by the consumer and need to be taken into account in a sheep meat eating quality classification scheme. These are considerations for future milestones in this project. The current estimates of the variance associated with Kill Group are an indication of gains that might be made by implementing a consistent quality control program in the meat processing industry based upon an agreed and scientifically defined best practice.

The sex, birth rank and dam breed type of the lamb did not affect any of the eating quality variables. Only the amount of intra – muscular fat and the Shear Force 5 variables were related to the eating quality variables of the consumer star classification.

It is notable that the BLUP ranks of the sires change, sometimes dramatically, for each of the EQ variables when the covariates intra – muscular fat and shear force are included. The application of such estimates thus needs thought. Clearly aspects of the EQ variables associated with e.g. intra – muscular fat and related to particular sires would have an influence on the breeding value of that sire. If intra – muscular fat is included as a covariate then the sire BLUP estimates relate to effects on the EQ variables that are independent of intra – muscular fat. Thus, the objective of using either estimate (with or without a covariate) needs to be clearly defined.

The analysis of the Star categories by generalised linear models showed similar trends for sire breed and Kill Group that were observed with the EQ variables, taking into account the uncertainty associated by placing a sample into 1 of 5 classifications. Only the differences between Star Classifications 1, 2 and 3 verses Star Classifications 4 and 5 could be distinguished for sire breed and Kill Group differences in both the Loin and Topside cuts. The difference between Star Classification 3 and Star Classification 5 could only be distinguished in the Loin cut.

There are significant ($P < 0.01$) sire variance components for all the EQ variables except smell. The significance of these components may have more to do with the size of the data set than the amount of the sire influence. Excluding the intra – muscular fat measurement from the statistical model modified the variance components slightly, but clearly the source of this effect was associated with elements other than the intra – muscular fat or the Shear force. There is a significant ($P < 0.01$) sire variance component for the Star Classification 1, 2 and 3 verses Star Classification 4 and 5 in both Loin and Topside, but not for the Star Classification 3 verses Star Classification 5 in the Loin. This probably reflects the extra uncertainty introduced in allocating a classification to each meat sample.

The BLUP estimates for the sire within sire breed within Kill Group effects for the EQ variables are highly correlated for the Topside cut, but the Tender variable is poorly related to Juicy, Flavour and Overall Liking in the Loin cut. This is an issue that might merit further consideration. It might indicate that something extra related to tenderness can be discerned in the Loin but not in the Topside. Perhaps the Loin exhibits a greater range of tenderness that can be identified then the Topside.

It has been observed that consumer judgement of meat eating quality exhibits considerable heterogeneity, and that this has the potential to disturb the analysis of this data by violating the assumptions underpinning the analysis. However, the inclusion of a random effect for consumer within pick dealt with this problem. The results of the model residuals for the Tender EQ variable are illustrated in Figure 1.

Previously this problem has been addressed by clipping the data, that is, by removing a proportion of extreme consumer responses. The approach assumes that these observations are not part of the population under investigation, perhaps because the consumers have made a mistake, or because some unexplained external event has contaminated the data. However, this raises the issue of exactly what population the analysis is making inference for? If the extreme events are indeed mistakes of one sort or another then removing them gives a better definition of the population of interest. But if instead these events are a characteristic of the population of interest then removing them is misleading.

The position taken here is that these events are characteristic of the population of interest and merit study. This is supported by large consumer within pick variance component compared with the pick variance component. The consumer intra – class correlation is about 0.4 for most of the EQ variables, which indicates that each consumer is relatively consistent in their evaluations. This is hard to justify if the deviations are due to mistakes and confusion. Rather, that this behaviour is an observed attribute of consumer judgement when eating lamb meat.

In this milestone the task is to evaluate the sire contributions to lamb meat eating quality, so including a random variable for consumer within pick addresses this problem adequately for these inferences to be made. However, in future milestones where the design of a suitable eating quality index is required this issue will need to be considered further.

Table 1.1:.The fixed effects and their standard errors for each of the EQ variables for the Loin

Sire Breed	Smell	Tender	Juicy	Flavour	Overall Liking
Bond	79.6 ± 2.23	79.0 ± 3.20	54.8 ± 3.13	60.9 ± 2.90	61.7 ± 2.90
Border Leicester	80.4 ± 0.99	78.6 ± 1.47	53.5 ± 1.43	59.5 ± 1.30	60.1 ± 1.31
Coopworth	79.0 ± 0.88	78.3 ± 1.34	52.4 ± 1.30	57.2 ± 1.18	57.9 ± 1.19
Corriedale	79.3 ± 1.01	80.3 ± 1.56	54.4 ± 1.50	59.4 ± 1.35	60.5 ± 1.37
Dohne Merino	80.7 ± 0.87	79.9 ± 1.33	52.1 ± 1.29	57.6 ± 1.16	58.6 ± 1.18
Merino	81.0 ± 0.73	81.5 ± 1.09	55.6 ± 1.08	60.3 ± 0.96	61.5 ± 0.96
Poll Dorset	80.5 ± 0.69	73.4 ± 0.79	48.0 ± 0.77	55.3 ± 0.67	54.7 ± 0.68
Poll Merino	80.7 ± 0.84	80.7 ± 1.25	55.2 ±1.23	60.1 ± 1.11	60.8 ± 1.11
Prime Samm	80.5 ± 0.93	79.1 ± 1.38	53.4 ± 1.35	58.5 ± 1.22	57.6 ± 1.23
Suffolk	79.7 ± 0.63	79.2 ± 1.05	52.8 ± 1.00	59.2 ± 0.88	59.6 ± 0.90
Texel	80.6 ± 0.61	75.2 ± 1.01	49.8 ± 0.96	56.4 ± 0.84	56.6 ± 0.87
White Suffolk	80.4 ± 0.93	78.3 ± 1.20	50.8 ± 1.21	58.6 ± 1.08	58.8 ± 1.10
Covariates					
Intra – muscular fat	0.74 ± 0.21**	1.56 ± 0.28**	5.03 ± 1.28**	5.42 ± 0.19**	5.63 ± 1.18**
IF Fat quadratic	NS	NS	-0.26 ± 0.12*	-0.34 ± 0.11**	-0.34 ± 0.11**
Shear force 5	-0.08 ± 0.03**	0.33 ± 0.04**	-0.23 ± 0.04**	-0.16 ± 0.04**	-0.22 ± 0.04**

Breed Effects without Covariate Corrections

Sire Breed	Smell	Tender	Juicy	Flavour	Overall Liking
Bond	71.4 ± 2.01	77.9 ± 3.01	74.3 ± 2.99	75.0 ± 2.68	77.8 ± 2.73
Border Leicester	70.1 ± 0.94	76.9 ± 1.51	71.0 ± 1.49	73.9 ± 1.79	75.9 ± 1.33
Coopworth	68.5 ± 0.85	76.1 ± 1.39	69.7 ± 1.38	71.6 ± 1.19	71.6 ± 1.22
Corriedale	68.1 ± 0.98	77.7 ± 1.61	71.5 ± 1.59	73.1 ± 1.37	75.4 ± 1.42
Dohne Merino	69.9 ± 0.82	77.8 ± 1.36	69.7 ± 1.34	72.0 ± 1.15	74.3 ± 1.19

Merino	69.9 ± 0.67	80.0 ± 1.10	73.5 ± 1.12	75.0 ± 0.92	77.6 ± 0.94
Poll Dorset	69.4 ± 0.65	70.5 ± 0.83	64.6 ± 0.82	68.7 ± 0.66	69.4 ± 0.68
Poll Merino	69.0 ± 0.78	77.9 ± 1.28	72.2 ± 1.29	74.1 ± 1.08	76.0 ± 1.11
Prime Samm	70.6 ± 0.89	79.6 ± 1.42	73.0 ± 1.41	74.3 ± 1.22	75.2 ± 1.25
Suffolk	68.9 ± 0.62	77.6 ± 1.12	70.6 ± 1.09	73.5 ± 0.91	75.3 ± 0.95
Texel	69.4 ± 0.56	72.7 ± 1.04	65.9 ± 1.02	69.5 ± 0.83	70.7 ± 0.88
White Suffolk	69.5 ± 0.76	76.4 ± 1.42	70.1 ± 1.41	71.6 ± 1.21	74.4 ± 1.24

Kill Group	Smell	Tender	Juicy	Flavour	Overall Liking
219K09	81.7 ± 1.00	80.8 ± 1.29	57.5 ± 1.31	61.6 ± 1.23	62.7 ± 1.23
261K09	79.6 ± 0.97	77.5 ± 1.30	51.8 ±1.29	57.5 ± 1.22	58.0 ±1.21
272A09	79.4 ± 0.92	79.5 ± 1.19	50.7 ± 1.19	58.0 ± 1.13	58.6 ± 1.12
297A09	80.3 ± 0.96	78.9 ± 1.20	53.0 ± 1.21	59.8 ± 1.16	60.2 ± 1.15
331A09	80.4 ± 1.33	78.3 ± 1.59	54.3 ± 1.62	57.9 ± 1.54	58.3 ± 1.54
331K09	78.8 ± 1.10	75.4 ± 1.39	48.8 ± 1.39	56.7 ± 1.33	56.3 ± 1.32
359A09	80.3 ± 1.05	78.6 ± 1.38	52.2 ± 1.33	57.7 ± 1.28	59.0 ± 1.26

Table 2.1: The fixed effects and their standard errors for each of the EQ variables for the Topside

Sire Breed	Smell	Tender	Juicy	Flavour	Overall
Bond	77.1 ± 2.34	63.3 ± 4.11	41.7 ± 3.48	64.6 ± 3.39	65.7 ± 3.55
Border Leicester	73.9 ± 1.04	71.0 ±1.89	45.0 ± 1.60	64.1 ± 1.53	66.5 ± 1.62
Coopworth	74.2 ± 0.93	68.2 ± 1.73	41.5 ± 1.45	62.8 ± 1.39	63.8 ± 1.48
Corriedale	74.3 ± 1.06	71.8 ± 2.00	46.2 ± 1.66	64.3 ± 1.60	67.6 ± 1.70

Dohne Merino	74.2 ± 0.91	72.3 ± 1.71	43.7 ± 1.43	63.3 ± 1.37	66.1 ± 1.45
Merino	73.5 ± 0.76	71.1 ± 1.41	44.9 ± 1.21	63.0 ± 1.12	65.4 ± 1.20
Poll Dorset	74.8 ± 0.88	71.1 ± 1.62	40.4 ± 0.87	59.2 ± 0.79	61.2 ± 0.86
Poll Merino	72.7 ± 0.52	64.4 ± 1.03	41.1 ± 1.39	64.4 ± 1.30	67.1 ± 1.39
Prime Samm	73.9 ± 0.97	73.2 ± 1.73	45.3 ± 1.50	63.7 ± 1.43	66.3 ± 1.52
Suffolk	73.9 ± 0.68	68.1 ± 1.37	42.2 ± 1.13	61.7 ± 1.07	63.4 ± 1.15
Texel	73.3 ± 0.64	66.6 ± 1.30	42.4 ± 1.06	60.3 ± 1.01	62.8 ± 1.08
White Suffolk	73.4 ± 0.86	68.7 ± 1.61	42.1 ± 1.35	62.5 ± 1.28	64.7 ± 1.37
Covariates					
Intra – muscular fat	0.06 ± 0.21	1.01 ± 0.36*	1.41 ± 0.31**	0.93 ± 0.30**	0.96 ± 0.31**
Shear force 5	-0.02 ± 0.03	-0.20 ± 0.05**	-0.10 ± 0.05*	-0.11 ± 0.04*	-0.18 ±0.05**

Breed Effects without Covariate Corrections

Sire Breed	Smell	Tender	Juicy	Flavour	Overall Liking
Bond	71.5 ± 2.08	50.7 ± 3.74	52.7 ± 3.19	63.2 ± 3.07	60.4 ± 3.25
Border Leicester	67.6 ± 0.98	54.5 ± 1.84	54.5 ± 1.58	60.7 ± 1.49	58.2 ± 1.59
Coopworth	67.3 ± 0.89	50.7 ± 1.69	50.3 ± 1.45	58.3 ± 1.36	54.5 ± 1.46
Corriedale	67.5 ± 1.02	53.1 ± 1.97	53.9 ± 1.67	59.0 ± 1.58	57.3 ± 1.69
Dohne Merino	67.5 ± 0.84	54.1 ± 1.64	52.6 ± 1.39	58.4 ± 1.31	56.7 ± 1.41
Merino	66.6 ± 0.68	54.1 ± 1.30	54.0 ± 1.17	58.9 ± 1.04	56.6 ± 1.13
Poll Dorset	66.1 ± 0.47	46.6 ± 0.97	48.6 ± 0.86	54.6 ± 0.75	51.5 ± 0.83
Poll Merino	68.0 ± 0.80	53.5 ± 1.52	52.9 ± 1.34	59.8 ± 1.22	57.7 ± 1.32
Prime Samm	66.8 ± 0.92	56.5 ± 1.73	54.3 ± 1.49	60.0 ± 1.40	58.1 ± 1.50
Suffolk	67.0 ± 0.66	50.9 ± 1.35	51.1 ± 1.18	57.5 ± 1.06	54.6 ± 1.16
Texel	66.8 ± 0.58	49.5 ± 1.24	50.5 ± 1.05	56.0 ± 0.92	53.7 ± 1.05

White Suffolk	66.7 ± 0.90	51.6 ± 1.73	52.0 ± 1.49	58.4 ± 1.50	55.8 ± 1.34

Kill Group	Smell	Tender	Juicy	Flavour	Overall
219K09	75.4 ± 0.90	66.9 ± 1.55	44.3 ± 1.43	63.5 ± 1.38	64.9 ± 1.38
261K09	74.0 ± 0.86	69.3 ±1.60	45.3 ± 1.45	63.1 ± 1.39	65.9 ± 1.40
272A09	75.1 ± 0.79	72.4 ±1.46	45.7 ± 1.34	65.8 ± 1.28	68.2 ± 1.28
297A09	74.1 ± 0.84	74.7 ± 1.44	45.9 ± 1.34	65.0 ± 1.30	68.3 ± 1.28
331A09	74.8 ± 1.33	67.4 ± 1.78	40.5 ± 1.71	59.9 ± 1.70	62.1 ± 1.66
331K09	73.3 ± 1.01	60.0 ± 1.65	37.9 ± 1.53	59.0 ± 1.49	58.7 ± 1.48
359A09	73.8 ± 0.97	69.0 ± 1.58	43.3 ± 1.47	62.6 ± 1.42	65.1 ± 1.42

Table 3.1: Multiple comparison for the sire breeds and Kill Groups for the Loin

Loin Tender

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Corriedale	-6.90	0.01
Poll Dorset	v	Dohne Merino	-6.57	0.01
Poll Dorset	v	Merino	-8.09	0.01
Texel	v	Merino	-6.29	0.01
White Suffolk	v	Merino	-4.99	0.01
Poll Merino	v	Poll Dorset	7.35	0.01
Suffolk	v	Poll Dorset	5.81	0.01
Prime Samm	v	Poll Dorset	5.74	0.02
Texel	v	Poll Merino	-5.55	0.03
White Suffolk	v	Poll Dorset	3.10	0.05

Kill Group Comparison	Difference in estimates	Significance

331K09	v	272A09	-12.41	0.001
331K09	v	297A09	-14.65	0.001
359A09	v	331K09	11.70	0.001
331K09	v	261K09	-9.33	0.004
297A09	v	219K09	7.72	0.021
331K09	v	272A09	-12.41	0.001

Loin Juicy

Sire Breed Comparison			Difference in estimates	Significance
Prime Samm	v	Poll Dorset	5.41	0.03
Poll Dorset	v	Border Leicester	-5.50	0.03
Texel	v	Poll Merino	-5.43	0.03

Kill Group Comparison			Difference in estimates	Significance
272A09	v	219K09	-6.86	0.001
331K09	v	219K09	-8.76	0.001
261K09	v	219K09	-5.77	0.034

Loin Flavour

Kill Group Comparison			Difference in estimates	Significance
Poll Dorset	v	Merino	-5.06	0.01
Suffolk	v	Poll Dorset	3.96	0.01
Poll Merino	v	Poll Dorset	4.78	0.01

Loin Overall

Kill Group Comparison			Difference in estimates	Significance
Poll Dorset	v	Border Leicester	-5.49	0.01
Poll Dorset	v	Corriedale	-5.83	0.01
Poll Dorset	v	Merino	-6.83	0.01
Texel	v	Merino	-4.90	0.01
Poll Merino	v	Poll Dorset	6.11	0.01
Suffolk	v	Poll Dorset	4.94	0.01
White Suffolk	v	Merino	-4.19	0.01
White Suffolk	v	Poll Dorset	2.63	0.04

Kill Group Comparison			Difference in estimates	Significance
331K09	v	219K09	2.04	0.03

Table 4.1: Multiple comparison for the sire breeds and Kill Groups for the Topside

Topside Smell.

No significant sire breed effects for smell

Topside Tender

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Dohne Merino	-7.91	0.01
Poll Dorset	v	Merino	-6.73	0.01
Prime Samm	v	Poll Dorset	8.76	0.01
Poll Merino	v	Poll Dorset	6.74	0.02

White Suffolk	v	Prime Samm	-7.12	0.02
Poll Dorset	v	Corriedale	-7.35	0.05

Kill Group Comparison			Difference in estimates	Significance
331K09	v	272A09	-12.41	0.001
331K09	v	297A09	-14.65	0.001
359A09	v	331K09	11.70	0.001
331K09	v	261K09	-9.33	0.004
297A09	v	219K09	7.72	0.021

Topside Juicy

No significant sire breeds for juicy

Kill Group Comparison			Difference in estimates	Significance
331K09	v	297A09	-7.98	0.001
331K09	v	272A09	-7.85	0.011
331K09	v	261K09	-7.45	0.016

Topside Flavour

Sire Breed Comparison			Difference in estimates	Significance
Poll Merino	v	Poll Dorset	5.19	0.03

Kill Group Comparison			Difference	Significance
331K09	v	297A09	-6.03	0.02
331K09	v	272A09	-6.81	0.03

Topside Overall

Sire Breed Comparison			Difference in estimates	Significance
Poll Merino	v	Poll Dorset	5.98	0.01
Poll Dorset	v	Corriedale	-6.41	0.04

Kill Group Comparison			Difference in estimates	Significance
331K09	v	272A09	-9.54	0.001
331K09	v	297A09	-9.56	0.001
331K09	v	261K09	-7.21	0.015
359A09	v	331K09	7.34	0.039

Table 5.1: The fixed effects and their standard errors for the significant star classifications for the loin

Sire Breed	Star 1, 2, 3 v Star 4,5		Star 3 v Star 5	
	Logit	Proportion in Star 4, 5	Logit	Proportio n in Star 5
Bond	0.37 ± 0.36	59	0.23 ± 0.37	56
Border Leicester	0.09 ± 0.16	52	0.00 ± 0.16	50
Coopworth	0.00 ± 0.14	50	0.09 ± 0.14	52
Corriedale	0.05 ± 0.16	51	-0.10 ± 0.16	48
Dohne Merino	0.05 ± 0.14	51	0.05 ± 0.15	51

Merino	0.39 ± 0.12	60	0.34 ± 0.13	58
Poll Dorset	-0.49 ± 0.08	38	-0.28 ± 0.08	43
Poll Merino	0.21± 0.13	55	0.11 ± 0.14	53
Prime Samm	-0.08 ± 0.15	48	0.03 ± 0.15	51
Suffolk	0.0 ± 0.10	50	-0.02 ± 0.11	50
Texel	-0.30 ± 0.09	43	-0.19 ± 0.10	45
White Suffolk	-0.03 ± 0.16	49	-0.02 ± 0.12	50
Covariates				
Intra – muscular fat	0.64 ± 0.15***		0.14 ± 0.03***	
IF Fat quadratic	-0.04 ± 0.01**			
Shear force 5	0.03 ± 0.01**		-0.02 ± 0.005***	

Kill Group	Star 1, 2, 3 v Star 4,5		Star 3 v Star 5	
219K09	0.43 ± 0.10	61	0.25 ± 0.09	56
261K09	0.07 ± 0.10	52	0.10 ± 0.10	52
272A09	-0.16 ± 0.09	46	-0.17 ± 0.09	46
297A09	0.16 ± 0.09	54	0.13 ± 0.09	53
331A09	-0.16 ± 0.12	46	-0.13 ± 0.11	47
331K09	-0.29 ± 0.11	43	-0.20 ± 0.11	45
359A09	-0.01 ± 0.10	50	0.00 ± 0.10	50

Table 6.1: The fixed effects and their standard errors for the significant star classifications for the topside

Sire Breed	Star 1, 2,3 v Star 4, 5	
	Logit	Proportion in Star 4, 5
Bond[#]	0.37 ± 0.38	59
Border Leicester	0.06 ± 0.18	51
Coopworth	-0.23 ± 0.18	44
Corriedale	0.27 ± 0.19	57
Dohne Merino	0.14 ± 0.16	53
Merino	-0.08 ± 0.14	48
Poll Dorset	-0.38 ± 0.10	41
Poll Merino	0.07 ± 0.15	52
Prime Samm	0.07 ± 0.17	52
Suffolk	-0.11 ± 0.13	47
Texel	-0.06 ± 0.12	49

White Suffolk	-0.01 ± 0.15	50
Covariates		
Intra – muscular fat	0.08 ± 0.04*	
Shear force 5	-0.01 ± 0.01	

Low numbers

Kill Group	Star 1, 2,3 v Star 4, 5	
219K09	-0.08 ± 0.10	48
261K09	-0.02 ± 0.11	50
272A09	0.22 ± 0.10	61
297A09	0.44 ± 0.09	61
331A09	-0.08 ± 0.11	48
331K09	-0.42 ± 0.12	40
359A09	-0.01 ± 0.10	50

Table 7.1: Multiple comparison for the sire breeds and Kill Groups for the Loin

Star 1, 2, 3 v Star 4, 5

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Merino	-0.91	0.01
Texel	v	Merino	-0.72	0.01
White Suffolk	v	Merino	-0.69	0.01
Poll Merino	v	Poll Dorset	0.74	0.01
Suffolk	v	Poll Dorset	0.55	0.01

Kill Group Comparison	Difference in estimates	Significance

272A09	v	219K09	-0.59	0.00
331K09	v	219K09	-0.73	0.00
331K09	v	297A09	-0.49	0.01
331A09	v	219K09	-0.57	0.03

Star 3 v Star 5

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Merino	-1.22	0.01
White Suffolk	v	Merino	-1.04	0.01
Poll Merino	v	Poll Dorset	1.13	0.01
Suffolk	v	Poll Dorset	0.76	0.01
Poll Dorset	v	Dohne Merino	-0.97	0.02
White Suffolk	v	Poll Merino	-0.95	0.02

Kill Group Comparison			Difference in estimates	Significance
272A09	v	219K09	-0.42	0.005

Table 8.1: Multiple comparison for the sire breeds and Kill Groups for the Topside

Star 1, 2, 3 v Star 4, 5

NS sire breed effects

Kill Group Comparison			Difference in estimates	Significance
331K09	v	297A09	-0.87	0.001
297A09	v	219K09	0.53	0.004
331K09	v	272A09	-0.65	0.005
331A09	v	297A09	-0.52	0.010
359A09	v	297A09	-0.50	0.012

297A09	v	261K09	0.46	0.046
331K09	v	297A09	-0.87	0.001

Table 9.1: The variance components for the random effects for the Loin cut. The estimates without intra- muscular fat and shear force are in brackets

Random Effect	Smell	Tender	Juicy	Flavour	Overall
Consumer within Pick	149.8	137.0 (122.4)	183.8 (177.6)	150.5 (146.2)	147.0 (139.7)
Pick	8.01	9.47 (10.76)	9.99 (11.29)	9.43 (9.49)	9.53 (9.85)
Sire with sire breed within Kill group:	0.39 (NS)	15.97*** (20.0)	8.96*** (14.15)	5.70* (8.01)	7.98*** (11.72)
Residual	170.9	229.4 (235.5)	264.5 (269.7)	252.1 (255.5)	229.1 (234.7)

Table 10.1: The variance components for the random effects for the Topside cut. The estimates without intra- muscular fat and shear force are in brackets

Random Effect	Smell	Tender	Juicy	Flavour	Overall
Consumer within Pick	161.7	183.3 (182.2)	202.9 (204.4)	178.9 (174.7)	178.1 (174.7
Pick	9.71	7.13 (6.16)	7.35 (6.80)	9.29 (8.49)	7.83 (7.19)
Sire with sire breed within Kill group:	0.089 (NS)	23.75*** (26.80)	9.39** (12.04)	11.03*** (12.36)	13.40*** (16.11)
Residual	182.2	417.9 (421.3)	347.8 (350.1)	319.2 (322.6)	341.3 (343.2)

Table 11.1: The best linear unbiased predictors (BLUP) for each of the sires on each of the EQ variables for the Loin cut.

Sire	Breed	Tender	Juicy	Flavour	Overall
s020041200707J039	Border Leicester	3.09	1.07	0.72	1.57
s020041200707J040	Border Leicester	-2.85	-1.56	-1.44	-2.53
s0219292007070261	Border Leicester	-4.24	-1.20	-0.19	-1.24
s0244112006060369	Border Leicester	-3.49	-0.44	-0.29	-1.02
s0246862007070179	Border Leicester	-2.85	-0.89	-0.64	-1.28
s0300182004045220	Corriedale	-3.67	-1.02	-1.09	-1.90
s0300362005050134	Corriedale	-1.21	-0.88	-0.34	-0.81
s0315272003030360	Corriedale	-3.20	-2.80	-1.08	-3.14
s0318972006060386	Corriedale	-3.49	-1.47	-0.66	-1.17
s0600032006060121	Bond	-3.09	-0.51	-0.56	-1.68
s1500152003030196	Coopworth	-4.49	-1.07	-0.89	-1.74
s1500292007070244	Coopworth	-2.46	-2.27	-0.52	-1.63
s1500392006061009	Coopworth	-2.02	0.50	0.19	0.10
s1500482007070769	Coopworth	-3.98	-1.77	-0.89	-2.26
s1500622006060070	Coopworth	-1.54	-0.46	-0.51	-1.68
s1600012008080010	Poll Dorset	-1.95	-1.22	-0.99	-1.87
s1601852007070369	Poll Dorset	-3.78	-1.04	-0.72	-1.86
s1611432007070025	Poll Dorset	-3.46	0.02	0.08	-0.51
s1611582007070190	Poll Dorset	-2.14	0.16	-0.06	-0.70
s1612352007072025	Poll Dorset	-2.01	-2.45	-1.45	-2.21
s1614152007070440	Poll Dorset	-3.95	-2.16	-1.78	-3.24
s1618922006060050	Poll Dorset	-1.09	-0.46	-0.46	-0.79
s1619722006061831	Poll Dorset	-0.97	-1.10	-0.88	-1.25

s1622882007070644	Poll Dorset	-1.15	-0.86	-1.16	-1.85
s1623682007070468	Poll Dorset	-5.06	-1.06	-0.73	-2.02
s1636772007070839	Poll Dorset	-7.80	-1.00	-1.50	-2.52
s1637212007070311	Poll Dorset	-1.13	-0.99	-0.21	-0.88
s1640732007070364	Poll Dorset	-4.28	-2.55	-1.42	-2.75
s1700622007070144	Texel	-3.58	0.24	0.04	-0.38
s1700802007071532	Texel	-1.57	-1.27	-0.38	-1.32
s1702232007070046	Texel	-5.01	-1.40	-0.90	-1.88
s1704062007070028	Texel	-1.74	-0.61	-0.05	-0.73
s1704202007070224	Texel	-3.33	-1.24	-1.21	-2.33
s1900282007071494	Suffolk	-3.17	-1.07	-0.81	-1.38
s1900602007070267	Suffolk	-3.52	-1.67	-1.24	-2.21
s1901112007077058	Suffolk	-3.08	-1.44	-1.54	-2.48
s1918502001010120	Suffolk	-2.56	0.13	-0.49	-1.27
s1920452007070508	Suffolk	-3.05	-1.46	-0.91	-1.63
s2300022007070098	White Suffolk	-5.70	-0.63	-0.05	-0.53
s2300092007070279	White Suffolk	-2.47	-0.04	-0.38	-0.97
s2300152007070143	White Suffolk	-3.32	-1.79	-1.11	-2.37
s2300262005050650	White Suffolk	1.95	-0.73	-0.99	-1.72
s2300262007072446	White Suffolk	-2.06	-0.78	-0.70	-1.40
s2300342007074914	White Suffolk	-3.28	-2.20	-0.85	-2.16
s2300432007070591	White Suffolk	-4.10	-0.61	0.13	-0.68
s2300912007070008	White Suffolk	-2.58	-1.90	-1.29	-2.42
s2301132007070040	White Suffolk	-4.55	-1.28	-0.75	-1.48
s2303182008080262	White Suffolk	-2.28	-0.80	-0.13	-0.59
s2303242007075630	White Suffolk	-5.12	-0.17	-0.45	-0.91
s2304502007071456	White Suffolk	-1.26	-0.72	-0.52	-1.40

s4800302008080078	Prime Samm	-3.26	-1.98	-0.58	-1.75
s4800392007070062	Prime Samm	-1.94	-2.52	-1.14	-2.30
s4800552007070068	Prime Samm	-2.03	-0.75	-0.20	-0.99
s4800872006060421	Prime Samm	-2.79	-2.02	-1.66	-2.74
s4800992006060191	Prime Samm	-5.00	-0.73	-0.49	-1.17
s5000482007070260	Merino	-1.07	-1.59	-2.30	-3.24
s5000872006060096	Merino	-0.23	0.47	-0.04	-0.70
s5007882007071254	Merino	-2.77	-0.45	0.03	-1.03
s5018852006TRIMPH	Merino	-1.59	-0.75	-0.58	-1.41
s5024252006023997	Merino	-5.34	-0.63	0.09	-0.63
s5030542004040585	Merino	-0.94	-1.90	-0.89	-1.78
s5030972005051737	Merino	-3.05	-1.90	-1.22	-2.83
s5034252006060205	Merino	-3.11	-1.34	-0.55	-1.49
s5037892007LB0753	Merino	-0.61	0.23	0.22	-0.21
s5038632006OL3626	Merino	-1.97	0.42	-0.49	-0.43
s5039462007OLY716	Merino	-3.97	-1.46	-0.90	-1.77
s5039822006060225	Merino	-3.59	-0.59	-0.82	-1.75
s5044702006060022	Merino	-3.63	-1.06	-0.84	-1.14
s5046152004040024	Merino	-3.00	-0.27	-0.57	-1.09
s5047432000000503	Merino	-1.78	-2.64	-1.27	-2.25
s5049022005005345	Merino	-6.41	-1.98	-1.63	-3.38
s5049162007070719	Merino	-3.63	-1.38	-1.08	-2.06
s50923420060C0573	Merino	-4.91	-0.80	-0.79	-1.67
s5100032007070949	Dohne Merino	-4.01	-1.35	-0.87	-1.89
s5100092007070376	Dohne Merino	-3.70	-1.29	-1.06	-2.03
s5100302005050068	Dohne Merino	-4.36	-0.80	-0.68	-1.13
s5100492007071700	Dohne Merino	-0.87	-0.96	-0.12	-0.93

s5101402006060368	Dohne Merino	-1.18	-1.16	-0.85	-2.16
s6004082007070069	Poll Merino	-2.68	-1.50	-0.17	-1.45
s6005532007070002	Poll Merino	-4.93	1.28	-0.51	-0.51
s6005712006060058	Poll Merino	-3.66	-1.05	0.13	-0.42
s6008152006060120	Poll Merino	-3.12	-0.94	0.00	-0.51
s6010532003031078	Poll Merino	-1.54	-3.25	-1.38	-2.91
s6010822007071257	Poll Merino	-3.11	-2.65	-1.27	-2.91
s6011272007070121	Poll Merino	-2.29	-1.03	-0.85	-1.35
s6012502004407812	Poll Merino	-4.61	0.31	0.58	-0.84
s6012882006063091	Poll Merino	-5.48	-1.24	-2.52	-3.26
s6013072005050165	Poll Merino	-2.05	-0.39	-0.73	-1.87
s6013162007070023	Poll Merino	-2.47	-0.73	-0.50	-1.04
s6013322004000WD2	Poll Merino	0.63	1.37	0.21	0.46
s6013562007000449	Poll Merino	-1.58	-1.64	-0.44	-1.12
s6013652006060052	Poll Merino	-3.68	-2.59	-2.65	-3.28
s6090542006066533	Poll Merino	-4.92	-1.80	-0.62	-1.81
s6091542004040062	Poll Merino	-6.40	-2.25	-1.77	-3.48

Table 12.1: The sires ranked by best linear unbiased predictor (BLUP) for each of the EQ variables for the Loin cut

Sire	Breed	Rank Tender	Rank Juicy	Rank Flavour	Rank Overall
s020041200707J039	Border Leicester	94	92	94	94
s020041200707J040	Border Leicester	52	25	11	13
s0219292007070261	Border Leicester	19	41	75	60
s0244112006060369	Border Leicester	35	78	72	69
s0246862007070179	Border Leicester	53	56	51	57

s0300182004045220	Corriedale	28	51	23	29
s0300362005050134	Corriedale	81	57	71	76
s0315272003030360	Corriedale	42	2	24	7
s0318972006060386	Corriedale	36	27	50	61
s0600032006060121	Bond	47	74	56	43
s1500152003030196	Coopworth	16	44	34	41
s1500292007070244	Coopworth	61	9	58	47
s1500392006061009	Coopworth	68	91	90	92
s1500482007070769	Coopworth	22	21	33	20
s1500622006060070	Coopworth	78	75	60	44
s1600012008080010	Poll Dorset	71	40	27	32
s1601852007070369	Poll Dorset	25	49	47	34
s1611432007070025	Poll Dorset	37	83	86	87
s1611582007070190	Poll Dorset	64	85	79	79
s1612352007072025	Poll Dorset	69	8	10	22
s1614152007070440	Poll Dorset	24	12	4	6
s1618922006060050	Poll Dorset	85	76	66	77
s1619722006061831	Poll Dorset	87	43	35	59
s1622882007070644	Poll Dorset	83	58	20	35
s1623682007070468	Poll Dorset	8	46	45	28
s1636772007070839	Poll Dorset	1	52	9	14
s1637212007070311	Poll Dorset	84	53	73	74
s1640732007070364	Poll Dorset	18	6	12	11
s1700622007070144	Texel	33	87	85	90
s1700802007071532	Texel	77	37	69	56
s1702232007070046	Texel	9	31	31	31
s1704062007070028	Texel	74	72	81	78

s1704202007070224	Texel	38	39	19	18
s1900282007071494	Suffolk	43	45	42	54
s1900602007070267	Suffolk	34	22	17	23
s1901112007077058	Suffolk	48	30	8	15
s1918502001010120	Suffolk	58	84	64	58
s1920452007070508	Suffolk	49	29	29	46
s2300022007070098	White Suffolk	4	69	80	84
s2300092007070279	White Suffolk	59	82	70	71
s2300152007070143	White Suffolk	39	20	22	17
s2300262005050650	White Suffolk	93	67	28	42
s2300262007072446	White Suffolk	65	62	48	52
s2300342007074914	White Suffolk	40	11	37	24
s2300432007070591	White Suffolk	20	71	89	81
s2300912007070008	White Suffolk	57	17	14	16
s2301132007070040	White Suffolk	15	36	44	49
s2303182008080262	White Suffolk	63	61	77	83
s2303242007075630	White Suffolk	7	81	67	73
s2304502007071456	White Suffolk	80	68	59	53
s4800302008080078	Prime Samm	41	15	53	40
s4800392007070062	Prime Samm	72	7	21	19
s4800552007070068	Prime Samm	67	63	74	70
s4800872006060421	Prime Samm	54	13	6	12
s4800992006060191	Prime Samm	10	65	63	62
s5000482007070260	Merino	86	24	3	5
s5000872006060096	Merino	91	90	82	80
s5007882007071254	Merino	55	77	84	68
s5018852006TRIMPH	Merino	75	64	54	51

s5024252006023997	Merino	6	70	87	82
s5030542004040585	Merino	88	18	32	37
s5030972005051737	Merino	50	16	18	10
s5034252006060205	Merino	45	34	57	48
s5037892007LB0753	Merino	90	86	92	91
s5038632006OL3626	Merino	70	89	65	88
s5039462007OLY716	Merino	23	28	30	38
s5039822006060225	Merino	32	73	41	39
s5044702006060022	Merino	30	47	40	63
s5046152004040024	Merino	51	80	55	66
s5047432000000503	Merino	73	4	16	21
s5049022005005345	Merino	2	14	7	2
s5049162007070719	Merino	31	32	25	26
s50923420060C0573	Merino	13	59	43	45
s5100032007070949	Dohne Merino	21	33	36	30
s5100092007070376	Dohne Merino	26	35	26	27
s5100302005050068	Dohne Merino	17	60	49	64
s5100492007071700	Dohne Merino	89	54	78	72
s5101402006060368	Dohne Merino	82	42	38	25
s6004082007070069	Poll Merino	56	26	76	50
s6005532007070002	Poll Merino	11	93	61	85
s6005712006060058	Poll Merino	29	48	88	89
s6008152006060120	Poll Merino	44	55	83	86
s6010532003031078	Poll Merino	79	1	13	8
s6010822007071257	Poll Merino	46	3	15	9
s6011272007070121	Poll Merino	62	50	39	55
s6012502004407812	Poll Merino	14	88	93	75

s6012882006063091	Poll Merino	5	38	2	4
s6013072005050165	Poll Merino	66	79	46	33
s6013162007070023	Poll Merino	60	66	62	67
s6013322004000WD2	Poll Merino	92	94	91	93
s6013562007000449	Poll Merino	76	23	68	65
s6013652006060052	Poll Merino	27	5	1	3
s6090542006066533	Poll Merino	12	19	52	36
s6091542004040062	Poll Merino	3	10	5	1

Table 13.1: The correlations between the sire BLUP estimates for each of the EQ variables for the Loin cut

	Tender	Juicy	Flavour	Overall Liking
Tender		0.22	0.27	0.37
Juicy			0.68	0.80
Flavour				0.90
Overall Liking				

Table 14.1: The sires best linear unbiased predictor (BLUP) and rankings for the Star Classification 1, 2, 3 verses Star Classification 4, 5 for the Loin cut.

Sire	Breed	Star 1, 2, 3 v Sta4 4, 5	Rank
s020041200707J039	Border Leicester	0.19	94
s020041200707J040	Border Leicester	-0.19	31
s0219292007070261	Border Leicester	-0.27	7
s0244112006060369	Border Leicester	-0.06	83
s0246862007070179	Border Leicester	-0.18	46
s0300182004045220	Corriedale	-0.24	15

s0300362005050134	Corriedale	0.06	93
s0315272003030360	Corriedale	-0.02	89
s0318972006060386	Corriedale	-0.26	8
s0600032006060121	Bond	-0.18	43
s1500152003030196	Coopworth	-0.16	55
s1500292007070244	Coopworth	-0.05	85
s1500392006061009	Coopworth	-0.25	12
s1500482007070769	Coopworth	-0.19	32
s1500622006060070	Coopworth	-0.17	51
s1600012008080010	Poll Dorset	-0.15	57
s1601852007070369	Poll Dorset	-0.13	67
s1611432007070025	Poll Dorset	-0.09	78
s1611582007070190	Poll Dorset	-0.15	58
s1612352007072025	Poll Dorset	-0.20	26
s1614152007070440	Poll Dorset	-0.20	28
s1618922006060050	Poll Dorset	-0.21	23
s1619722006061831	Poll Dorset	-0.03	88
s1622882007070644	Poll Dorset	-0.22	21
s1623682007070468	Poll Dorset	-0.22	19
s1636772007070839	Poll Dorset	-0.26	11
s1637212007070311	Poll Dorset	-0.03	87
s1640732007070364	Poll Dorset	-0.17	54
s1700622007070144	Texel	-0.20	25
s1700802007071532	Texel	-0.08	80
s1702232007070046	Texel	-0.19	29
s1704062007070028	Texel	-0.11	73
s1704202007070224	Texel	-0.18	44

s1900282007071494	Suffolk	-0.17	52
s1900602007070267	Suffolk	-0.17	53
s1901112007077058	Suffolk	-0.12	71
s1918502001010120	Suffolk	-0.17	49
s1920452007070508	Suffolk	-0.16	56
s2300022007070098	White Suffolk	-0.12	69
s2300092007070279	White Suffolk	-0.19	33
s2300152007070143	White Suffolk	-0.09	77
s2300262005050650	White Suffolk	-0.12	68
s2300262007072446	White Suffolk	-0.13	64
s2300342007074914	White Suffolk	-0.21	22
s2300432007070591	White Suffolk	-0.19	37
s2300912007070008	White Suffolk	-0.18	38
s2301132007070040	White Suffolk	-0.17	50
s2303182008080262	White Suffolk	-0.19	35
s2303242007075630	White Suffolk	-0.21	24
s2304502007071456	White Suffolk	-0.08	79
s4800302008080078	Prime Samm	-0.18	39
s4800392007070062	Prime Samm	-0.19	30
s4800552007070068	Prime Samm	-0.05	84
s4800872006060421	Prime Samm	-0.12	70
s4800992006060191	Prime Samm	-0.26	10
s5000482007070260	Merino	-0.14	61
s5000872006060096	Merino	-0.10	76
s5007882007071254	Merino	-0.13	66
s5018852006TRIMPH	Merino	0.01	90
s5024252006023997	Merino	-0.25	13

s5030542004040585	Merino	-0.20	27
s5030972005051737	Merino	-0.31	4
s5034252006060205	Merino	-0.22	20
s5037892007LB0753	Merino	-0.10	74
s5038632006OL3626	Merino	0.04	91
s5039462007OLY716	Merino	-0.18	47
s5039822006060225	Merino	-0.14	60
s5044702006060022	Merino	-0.18	45
s5046152004040024	Merino	-0.34	3
s5047432000000503	Merino	-0.19	36
s5049022005005345	Merino	-0.26	9
s5049162007070719	Merino	-0.19	34
s50923420060C0573	Merino	-0.13	65
s5100032007070949	Dohne Merino	-0.22	17
s5100092007070376	Dohne Merino	-0.18	40
s5100302005050068	Dohne Merino	-0.23	16
s5100492007071700	Dohne Merino	-0.05	86
s5101402006060368	Dohne Merino	-0.10	75
s6004082007070069	Poll Merino	-0.14	59
s6005532007070002	Poll Merino	-0.13	63
s6005712006060058	Poll Merino	-0.18	48
s6008152006060120	Poll Merino	-0.07	81
s6010532003031078	Poll Merino	-0.18	41
s6010822007071257	Poll Merino	-0.18	42
s6011272007070121	Poll Merino	-0.35	2
s6012502004407812	Poll Merino	-0.22	18
s6012882006063091	Poll Merino	-0.24	14

s6013072005050165	Poll Merino	0.05	92
s6013162007070023	Poll Merino	-0.13	62
s6013322004000WD2	Poll Merino	-0.07	82
s6013562007000449	Poll Merino	-0.12	72
s6013652006060052	Poll Merino	-0.37	1
s6090542006066533	Poll Merino	-0.27	6
s6091542004040062	Poll Merino	-0.29	5

Table 15.1: The best linear unbiased predictors (BLUP) for each of the sires on each of the EQ variables for the Topside cut.

Sire	Breed	Tender	Juicy	Flavour	Overall
s020041200707J039	Border Leicester	3.01	1.16	0.08	1.08
s020041200707J040	Border Leicester	-4.99	-2.17	-1.03	-2.43
s0219292007070261	Border Leicester	-3.01	-1.06	-0.47	-1.49
s0244112006060369	Border Leicester	-2.30	-0.68	0.59	-0.63
s0246862007070179	Border Leicester	-3.36	-1.80	-0.02	-1.00
s0300182004045220	Corriedale	-1.39	-0.28	0.82	0.07
s0300362005050134	Corriedale	-3.35	-1.26	-0.28	-0.85
s0315272003030360	Corriedale	-9.17	-3.34	-3.36	-5.06
s0318972006060386	Corriedale	-1.07	-0.81	0.32	-0.73
s0600032006060121	Bond	-2.59	-0.18	-0.20	-1.28
s1500152003030196	Coopworth	-1.66	-0.78	0.97	-0.33
s1500292007070244	Coopworth	-3.33	-1.76	-0.67	-1.73
s1500392006061009	Coopworth	-1.94	-0.39	0.60	-0.24
s1500482007070769	Coopworth	-5.84	-2.64	-1.65	-2.70
s1500622006060070	Coopworth	-2.28	-0.21	0.38	-0.35
s1600012008080010	Poll Dorset	-3.47	-2.07	-0.62	-1.08

s1601852007070369	Poll Dorset	-3.64	-1.50	-0.72	-1.56
s1611432007070025	Poll Dorset	-1.13	0.05	1.52	0.77
s1611582007070190	Poll Dorset	-3.18	-1.42	0.32	-0.77
s1612352007072025	Poll Dorset	-2.54	-1.01	-0.22	-1.20
s1614152007070440	Poll Dorset	-6.31	-2.81	-1.77	-3.33
s1618922006060050	Poll Dorset	0.55	0.27	1.68	1.08
s1619722006061831	Poll Dorset	-5.31	-0.94	-0.67	-2.12
s1622882007070644	Poll Dorset	-5.61	-1.67	-0.86	-2.85
s1623682007070468	Poll Dorset	-2.82	-1.01	-0.31	-1.57
s1636772007070839	Poll Dorset	-3.72	-1.73	-0.67	-1.37
s1637212007070311	Poll Dorset	-2.23	-1.30	0.21	-0.26
s1640732007070364	Poll Dorset	-4.19	-1.36	-0.06	-1.73
s1700622007070144	Texel	-1.41	-1.01	0.60	-0.21
s1700802007071532	Texel	-3.89	-1.22	-0.39	-1.17
s1702232007070046	Texel	-2.73	-1.10	0.34	-1.01
s1704062007070028	Texel	-3.11	-1.66	-0.71	-1.42
s1704202007070224	Texel	-2.59	-1.16	0.25	-0.81
s1900282007071494	Suffolk	-3.16	-0.37	0.18	-0.50
s1900602007070267	Suffolk	-4.52	-2.17	-0.64	-2.13
s1901112007077058	Suffolk	-1.18	-0.49	1.69	0.59
s1918502001010120	Suffolk	-2.19	-0.19	0.49	-0.34
s1920452007070508	Suffolk	-1.86	-1.01	0.43	-0.24
s2300022007070098	White Suffolk	-2.42	-1.15	0.36	-0.80
s2300092007070279	White Suffolk	-1.19	-0.44	0.04	-0.41
s2300152007070143	White Suffolk	-4.84	-1.12	-1.33	-2.36
s2300262005050650	White Suffolk	-5.25	-1.59	-0.61	-3.03
s2300262007072446	White Suffolk	-3.97	-1.63	-0.35	-1.28

s2300342007074914	White Suffolk	-2.92	-1.53	-0.78	-2.18
s2300432007070591	White Suffolk	-3.69	-1.16	-0.25	-1.54
s2300912007070008	White Suffolk	-3.61	-1.70	-0.57	-1.12
s2301132007070040	White Suffolk	-4.03	-1.40	-0.66	-1.62
s2303182008080262	White Suffolk	-0.89	-0.37	1.19	0.06
s2303242007075630	White Suffolk	-3.65	-1.11	0.18	-1.09
s2304502007071456	White Suffolk	-2.42	-0.83	0.36	-0.35
s4800302008080078	Prime Samm	-4.49	-1.56	-1.28	-2.68
s4800392007070062	Prime Samm	-1.83	-1.20	0.08	-0.67
s4800552007070068	Prime Samm	0.12	0.27	1.07	0.61
s4800872006060421	Prime Samm	-4.94	-1.24	-1.17	-2.10
s4800992006060191	Prime Samm	-3.22	-1.54	-0.60	-1.72
s5000482007070260	Merino	-4.25	-1.64	-2.30	-2.91
s5000872006060096	Merino	-4.65	-0.45	-0.72	-2.20
s5007882007071254	Merino	-4.38	-1.52	0.09	-1.54
s5018852006TRIMPH	Merino	-2.56	-1.15	-0.20	-0.55
s5024252006023997	Merino	-0.17	-0.22	0.60	0.59
s5030542004040585	Merino	-6.28	-1.65	-1.00	-2.56
s5030972005051737	Merino	-3.25	-1.28	-0.44	-1.09
s5034252006060205	Merino	-0.87	-0.54	1.63	0.62
s5037892007LB0753	Merino	1.72	-0.01	2.47	2.17
s5038632006OL3626	Merino	1.73	1.38	2.31	2.17
s5039462007OLY716	Merino	-3.93	-2.23	-0.69	-1.77
s5039822006060225	Merino	-5.43	-2.16	-0.96	-2.10
s5044702006060022	Merino	-3.78	-1.61	-0.36	-2.60
s5046152004040024	Merino	-4.20	-1.54	-0.41	-1.85
s5047432000000503	Merino	-4.97	-2.18	-1.25	-2.52

s5049022005005345	Merino	-6.33	-2.12	0.39	-2.24
s5049162007070719	Merino	-1.07	-0.64	1.12	0.45
s50923420060C0573	Merino	-4.65	-1.82	-1.61	-3.20
s5100032007070949	Dohne Merino	-3.66	-1.02	-0.39	-1.55
s5100092007070376	Dohne Merino	-4.52	-2.03	0.50	-1.09
s5100302005050068	Dohne Merino	-2.11	-0.77	0.18	-0.09
s5100492007071700	Dohne Merino	-2.14	-0.94	-0.03	-0.91
s5101402006060368	Dohne Merino	-1.72	-0.57	1.16	0.38
s6004082007070069	Poll Merino	-2.15	-0.65	-0.03	-0.82
s6005532007070002	Poll Merino	-0.52	-0.87	0.87	-0.23
s6005712006060058	Poll Merino	-5.16	-1.76	-1.44	-2.14
s6008152006060120	Poll Merino	-2.83	-1.41	-0.22	-1.64
s6010532003031078	Poll Merino	-3.96	-2.87	-2.12	-2.90
s6010822007071257	Poll Merino	-4.77	-1.97	-1.75	-2.44
s6011272007070121	Poll Merino	-2.76	-0.65	0.41	-0.95
s6012502004407812	Poll Merino	-4.20	-1.62	-0.26	-1.20
s6012882006063091	Poll Merino	-5.82	-1.59	-0.87	-1.39
s6013072005050165	Poll Merino	-3.98	-0.54	1.57	-0.21
s6013162007070023	Poll Merino	-1.26	-0.14	0.26	0.49
s6013322004000WD2	Poll Merino	-1.94	-0.37	1.46	-0.31
s6013562007000449	Poll Merino	3.66	1.07	2.03	0.67
s6013652006060052	Poll Merino	-3.35	-1.86	0.04	-2.23
s6090542006066533	Poll Merino	-5.89	-2.90	-2.09	-3.04
s6091542004040062	Poll Merino	-5.40	-1.80	-1.36	-3.01

Table 16.1: The sires ranked by best linear unbiased predictor (BLUP) for each of the EQ variables for the Topside cut

Sire	Breed	Rank Tender	Rank Juicy	Rank Flavour	Rank Overall
s020041200707J039	Border Leicester	93	93	56	91
s020041200707J040	Border Leicester	14	8	15	16
s0219292007070261	Border Leicester	52	55	34	39
s0244112006060369	Border Leicester	64	68	75	64
s0246862007070179	Border Leicester	43	18	52	54
s0300182004045220	Corriedale	78	82	79	81
s0300362005050134	Corriedale	44	44	42	57
s0315272003030360	Corriedale	1	1	1	1
s0318972006060386	Corriedale	83	65	65	62
s0600032006060121	Bond	58	86	48	44
s1500152003030196	Coopworth	76	66	81	71
s1500292007070244	Coopworth	46	20	25	29
s1500392006061009	Coopworth	71	78	77	75
s1500482007070769	Coopworth	6	5	7	10
s1500622006060070	Coopworth	65	84	69	69
s1600012008080010	Poll Dorset	42	12	30	52
s1601852007070369	Poll Dorset	40	37	21	35
s1611432007070025	Poll Dorset	82	89	87	90
s1611582007070190	Poll Dorset	49	38	64	61
s1612352007072025	Poll Dorset	61	58	46	46
s1614152007070440	Poll Dorset	3	4	5	2
s1618922006060050	Poll Dorset	90	91	90	92

s1619722006061831	Poll Dorset	11	61	27	24
s1622882007070644	Poll Dorset	8	23	19	9
s1623682007070468	Poll Dorset	55	57	41	34
s1636772007070839	Poll Dorset	36	21	26	42
s1637212007070311	Poll Dorset	66	42	61	73
s1640732007070364	Poll Dorset	28	41	49	30
s1700622007070144	Texel	77	60	76	77
s1700802007071532	Texel	34	46	37	47
s1702232007070046	Texel	57	54	66	53
s1704062007070028	Texel	51	24	23	40
s1704202007070224	Texel	59	49	62	59
s1900282007071494	Suffolk	50	79	60	66
s1900602007070267	Suffolk	21	9	29	23
s1901112007077058	Suffolk	81	75	91	86
s1918502001010120	Suffolk	67	85	73	70
s1920452007070508	Suffolk	73	59	72	74
s2300022007070098	White Suffolk	62	51	67	60
s2300092007070279	White Suffolk	80	77	54	67
s2300152007070143	White Suffolk	17	52	11	17
s2300262005050650	White Suffolk	12	31	31	5
s2300262007072446	White Suffolk	31	27	40	43
s2300342007074914	White Suffolk	53	35	20	21
s2300432007070591	White Suffolk	37	48	44	37
s2300912007070008	White Suffolk	41	22	33	48
s2301132007070040	White Suffolk	29	40	28	33
s2303182008080262	White Suffolk	85	81	85	80
s2303242007075630	White Suffolk	39	53	58	50

s2304502007071456	White Suffolk	63	64	68	68
s4800302008080078	Prime Samm	23	32	12	11
s4800392007070062	Prime Samm	74	47	55	63
s4800552007070068	Prime Samm	89	90	82	87
s4800872006060421	Prime Samm	16	45	14	25
s4800992006060191	Prime Samm	48	34	32	31
s5000482007070260	Merino	25	26	2	7
s5000872006060096	Merino	19	76	22	20
s5007882007071254	Merino	24	36	57	38
s5018852006TRIMPH	Merino	60	50	47	65
s5024252006023997	Merino	88	83	78	85
s5030542004040585	Merino	4	25	16	13
s5030972005051737	Merino	47	43	35	49
s5034252006060205	Merino	86	74	89	88
s5037892007LB0753	Merino	91	88	94	94
s5038632006OL3626	Merino	92	94	93	93
s5039462007OLY716	Merino	33	6	24	28
s5039822006060225	Merino	9	10	17	26
s5044702006060022	Merino	35	29	39	12
s5046152004040024	Merino	26	33	36	27
s5047432000000503	Merino	15	7	13	14
s5049022005005345	Merino	2	11	70	18
s5049162007070719	Merino	84	71	83	83
s50923420060C0573	Merino	20	16	8	3
s5100032007070949	Dohne Merino	38	56	38	36
s5100092007070376	Dohne Merino	22	13	74	51
s5100302005050068	Dohne Merino	70	67	59	79

s5100492007071700	Dohne Merino	69	62	50	56
s5101402006060368	Dohne Merino	75	72	84	82
s6004082007070069	Poll Merino	68	70	51	58
s6005532007070002	Poll Merino	87	63	80	76
s6005712006060058	Poll Merino	13	19	9	22
s6008152006060120	Poll Merino	54	39	45	32
s6010532003031078	Poll Merino	32	3	3	8
s6010822007071257	Poll Merino	18	14	6	15
s6011272007070121	Poll Merino	56	69	71	55
s6012502004407812	Poll Merino	27	28	43	45
s6012882006063091	Poll Merino	7	30	18	41
s6013072005050165	Poll Merino	30	73	88	78
s6013162007070023	Poll Merino	79	87	63	84
s6013322004000WD2	Poll Merino	72	80	86	72
s6013562007000449	Poll Merino	94	92	92	89
s6013652006060052	Poll Merino	45	15	53	19
s6090542006066533	Poll Merino	5	2	4	4
s6091542004040062	Poll Merino	10	17	10	6

Table 17.1: The correlations between the sire BLUP estimates for each of the EQ variables for the Topside cut

	Tender	Juicy	Flavour	Overall Liking
Tender		0.85	0.80	0.89
Juicy			0.79	0.84
Flavour				0.90
Overall Liking				

Table 18.1: The sires best linear unbiased predictor (BLUP) and rankings for the Star Classification 1, 2, 3 verses Star Classification 4, 5 for the Topside cut.

Sire	Breed	Star 1, 2, 3 v Sta4 4, 5	Rank
s020041200707J039	Border Leicester	0.19	94
s020041200707J040	Border Leicester	-0.19	29
s0219292007070261	Border Leicester	-0.27	6
s0244112006060369	Border Leicester	-0.06	83
s0246862007070179	Border Leicester	-0.18	38
s0300182004045220	Corriedale	-0.24	14
s0300362005050134	Corriedale	0.06	93
s0315272003030360	Corriedale	-0.02	89
s0318972006060386	Corriedale	-0.26	8
s0600032006060121	Bond	-0.18	39
s1500152003030196	Coopworth	-0.16	55
s1500292007070244	Coopworth	-0.05	84
s1500392006061009	Coopworth	-0.25	12
s1500482007070769	Coopworth	-0.19	30
s1500622006060070	Coopworth	-0.17	49

s1600012008080010	Poll Dorset	-0.15	57
s1601852007070369	Poll Dorset	-0.13	62
s1611432007070025	Poll Dorset	-0.09	77
s1611582007070190	Poll Dorset	-0.15	58
s1612352007072025	Poll Dorset	-0.20	25
s1614152007070440	Poll Dorset	-0.20	26
s1618922006060050	Poll Dorset	-0.21	22
s1619722006061831	Poll Dorset	-0.03	87
s1622882007070644	Poll Dorset	-0.22	17
s1623682007070468	Poll Dorset	-0.22	18
s1636772007070839	Poll Dorset	-0.26	9
s1637212007070311	Poll Dorset	-0.03	88
s1640732007070364	Poll Dorset	-0.17	50
s1700622007070144	Texel	-0.20	27
s1700802007071532	Texel	-0.08	79
s1702232007070046	Texel	-0.19	31
s1704062007070028	Texel	-0.11	73
s1704202007070224	Texel	-0.18	40
s1900282007071494	Suffolk	-0.17	51
s1900602007070267	Suffolk	-0.17	52
s1901112007077058	Suffolk	-0.12	68
s1918502001010120	Suffolk	-0.17	53
s1920452007070508	Suffolk	-0.16	56
s2300022007070098	White Suffolk	-0.12	69
s2300092007070279	White Suffolk	-0.19	32
s2300152007070143	White Suffolk	-0.09	78
s2300262005050650	White Suffolk	-0.12	70

s2300262007072446	White Suffolk	-0.13	63
s2300342007074914	White Suffolk	-0.21	23
s2300432007070591	White Suffolk	-0.19	33
s2300912007070008	White Suffolk	-0.18	41
s2301132007070040	White Suffolk	-0.17	54
s2303182008080262	White Suffolk	-0.19	34
s2303242007075630	White Suffolk	-0.21	24
s2304502007071456	White Suffolk	-0.08	80
s4800302008080078	Prime Samm	-0.18	42
s4800392007070062	Prime Samm	-0.19	35
s4800552007070068	Prime Samm	-0.05	85
s4800872006060421	Prime Samm	-0.12	71
s4800992006060191	Prime Samm	-0.26	10
s5000482007070260	Merino	-0.14	59
s5000872006060096	Merino	-0.10	74
s5007882007071254	Merino	-0.13	64
s5018852006TRIMPH	Merino	0.01	90
s5024252006023997	Merino	-0.25	13
s5030542004040585	Merino	-0.20	28
s5030972005051737	Merino	-0.31	4
s5034252006060205	Merino	-0.22	19
s5037892007LB0753	Merino	-0.10	75
s5038632006OL3626	Merino	0.04	91
s5039462007OLY716	Merino	-0.18	43
s5039822006060225	Merino	-0.14	60
s5044702006060022	Merino	-0.18	44
s5046152004040024	Merino	-0.34	3

s5047432000000503	Merino	-0.19	36
s5049022005005345	Merino	-0.26	11
s5049162007070719	Merino	-0.19	37
s50923420060C0573	Merino	-0.13	65
s5100032007070949	Dohne Merino	-0.22	20
s5100092007070376	Dohne Merino	-0.18	45
s5100302005050068	Dohne Merino	-0.23	16
s5100492007071700	Dohne Merino	-0.05	86
s5101402006060368	Dohne Merino	-0.10	76
s6004082007070069	Poll Merino	-0.14	61
s6005532007070002	Poll Merino	-0.13	66
s6005712006060058	Poll Merino	-0.18	46
s6008152006060120	Poll Merino	-0.07	81
s6010532003031078	Poll Merino	-0.18	47
s6010822007071257	Poll Merino	-0.18	48
s6011272007070121	Poll Merino	-0.35	2
s6012502004407812	Poll Merino	-0.22	21
s6012882006063091	Poll Merino	-0.24	15
s6013072005050165	Poll Merino	0.05	92
s6013162007070023	Poll Merino	-0.13	67
s6013322004000WD2	Poll Merino	-0.07	82
s6013562007000449	Poll Merino	-0.12	72
s6013652006060052	Poll Merino	-0.37	1
s6090542006066533	Poll Merino	-0.27	7
s6091542004040062	Poll Merino	-0.29	5

Table 19.1: Correlations Between Best Linear Unbiased Predictors (BLUP) for Sires for EQ Cuts on the Loin and the Topside

EQ Variable	Correlation
Tender	0.27
Juicy	0.56
Flavour	0.37
Overall Liking	0.56

Table 20.1: loin BLUP Estimates for the Sires Without Covariates

Sire	Breed	Tender	Juicy	Flavour	Overall
s020041200707J039	Border Leicester	2.14	0.77	0.53	1.25
s020041200707J040	Border Leicester	-1.77	-0.99	-0.71	-1.62
s0219292007070261	Border Leicester	-3.95	-1.01	-0.75	-2.14
s0244112006060369	Border Leicester	-0.86	0.83	-0.21	-0.24
s0246862007070179	Border Leicester	-2.55	-2.28	-0.63	-1.11
s0300182004045220	Corriedale	-2.65	-1.18	-0.77	-1.40
s0300362005050134	Corriedale	0.15	1.41	0.55	0.63
s0315272003030360	Corriedale	-1.62	-1.21	-1.83	-3.15
s0318972006060386	Corriedale	-3.46	-1.92	-0.85	-2.19
s0600032006060121	Bond	-2.14	-0.77	-0.53	-1.25
s1500152003030196	Coopworth	-2.92	-1.26	-0.61	-1.61
s1500292007070244	Coopworth	-1.23	-0.02	-0.30	-1.09
s1500392006061009	Coopworth	-1.15	-0.82	0.23	-0.28
s1500482007070769	Coopworth	-4.09	-1.57	-1.46	-2.32
s1500622006060070	Coopworth	-0.24	0.31	-0.07	-0.34
s1600012008080010	Poll Dorset	0.05	-0.49	0.37	0.12
s1601852007070369	Poll Dorset	-3.02	-1.06	-1.17	-2.38

s1611432007070025	Poll Dorset	-2.97	-1.91	-0.33	-1.09
s1611582007070190	Poll Dorset	-2.33	-0.14	-0.29	-1.31
s1612352007072025	Poll Dorset	-2.15	-2.36	-1.73	-3.14
s1614152007070440	Poll Dorset	-4.34	-2.17	-1.34	-3.04
s1618922006060050	Poll Dorset	0.58	0.36	0.20	-0.19
s1619722006061831	Poll Dorset	1.71	2.82	1.35	1.54
s1622882007070644	Poll Dorset	1.16	1.89	1.40	1.20
s1623682007070468	Poll Dorset	-4.92	-2.82	-1.68	-2.54
s1636772007070839	Poll Dorset	-8.10	-3.29	-2.50	-4.18
s1637212007070311	Poll Dorset	1.23	1.39	0.51	0.82
s1640732007070364	Poll Dorset	-3.29	-0.77	-0.71	-0.87
s1700622007070144	Texel	-2.08	-1.13	-1.21	-2.08
s1700802007071532	Texel	0.43	1.08	0.13	0.23
s1702232007070046	Texel	-5.40	-2.71	-1.47	-2.81
s1704062007070028	Texel	-1.15	-0.52	-0.32	-1.09
s1704202007070224	Texel	-2.50	-0.55	0.23	-0.49
s1900282007071494	Suffolk	-2.45	-0.81	-0.35	-1.27
s1900602007070267	Suffolk	-2.94	-1.35	-0.57	-1.13
s1901112007077058	Suffolk	-1.86	0.21	-0.33	-1.17
s1918502001010120	Suffolk	-1.84	-0.87	-0.74	-1.37
s1920452007070508	Suffolk	-1.59	-1.04	-0.67	-1.33
s2300022007070098	White Suffolk	-5.26	-2.62	-2.31	-3.74
s2300092007070279	White Suffolk	-1.37	0.35	-0.51	-1.06
s2300152007070143	White Suffolk	-2.30	-1.34	-0.77	-1.37
s2300262005050650	White Suffolk	1.37	1.20	1.13	0.87
s2300262007072446	White Suffolk	-0.94	-0.22	0.32	-0.05
s2300342007074914	White Suffolk	-0.25	0.96	-0.60	-0.44

s2300432007070591	White Suffolk	-3.41	-1.78	-1.05	-2.44
s2300912007070008	White Suffolk	-2.58	-1.00	-0.86	-1.63
s2301132007070040	White Suffolk	-3.98	-2.15	-0.76	-1.94
s2303182008080262	White Suffolk	-0.12	0.96	1.04	0.61
s2303242007075630	White Suffolk	-3.38	-0.72	-0.74	-1.44
s2304502007071456	White Suffolk	-1.33	-1.52	-0.40	-1.11
s4800302008080078	Prime Samm	-2.37	0.32	-0.01	0.41
s4800392007070062	Prime Samm	-0.64	0.45	-0.22	-0.70
s4800552007070068	Prime Samm	-1.22	-0.53	-0.15	-1.17
s4800872006060421	Prime Samm	-1.91	-0.46	-0.86	-1.41
s4800992006060191	Prime Samm	-4.40	-2.88	-1.25	-2.61
s5000482007070260	Merino	-0.97	-1.28	0.14	-0.71
s5000872006060096	Merino	1.58	1.55	1.64	1.01
s5007882007071254	Merino	-0.57	1.08	0.43	0.11
s5018852006TRIMPH	Merino	-2.40	-0.36	0.13	-0.42
s5024252006023997	Merino	-1.52	-0.66	-0.33	-0.98
s5030542004040585	Merino	-2.25	-1.10	-0.19	-0.82
s5030972005051737	Merino	-4.24	-1.65	-2.48	-3.36
s5034252006060205	Merino	-1.51	0.93	0.27	-0.38
s5037892007LB0753	Merino	-2.02	-1.95	-0.45	-1.69
s5038632006OL3626	Merino	-1.34	0.77	-0.09	-0.69
s5039462007OLY716	Merino	0.56	-0.42	0.38	-0.03
s5039822006060225	Merino	-1.67	-1.57	-0.57	-1.82
s5044702006060022	Merino	-3.30	-0.68	-0.54	-1.29
s5046152004040024	Merino	-2.45	-2.25	-0.96	-2.33
s5047432000000503	Merino	-2.10	-1.27	0.09	-0.27
s5049022005005345	Merino	-1.86	-0.75	-0.42	-0.94

s5049162007070719	Merino	-2.91	-0.73	-1.24	-2.17
s50923420060C0573	Merino	0.31	1.13	0.11	0.82
s5100032007070949	Dohne Merino	-5.88	-2.68	-1.55	-2.48
s5100092007070376	Dohne Merino	-2.31	-0.07	-0.41	-0.77
s5100302005050068	Dohne Merino	-4.66	-1.95	-1.61	-2.64
s5100492007071700	Dohne Merino	-2.59	-0.27	-0.25	-0.99
s5101402006060368	Dohne Merino	-2.31	0.07	-0.21	-0.99
s6004082007070069	Poll Merino	-4.35	-2.24	-1.24	-2.24
s6005532007070002	Poll Merino	-0.82	-0.46	-0.94	-1.38
s6005712006060058	Poll Merino	-0.18	-0.89	0.15	-0.48
s6008152006060120	Poll Merino	-1.28	-0.26	-0.08	-0.95
s6010532003031078	Poll Merino	-3.54	-1.41	-0.79	-2.03
s6010822007071257	Poll Merino	-3.93	-0.51	0.15	-1.71
s6011272007070121	Poll Merino	-2.64	-0.61	0.15	-0.32
s6012502004407812	Poll Merino	0.29	0.33	-0.13	0.25
s6012882006063091	Poll Merino	-1.24	-0.55	0.12	-0.40
s6013072005050165	Poll Merino	-1.08	-1.07	0.01	-0.66
s6013162007070023	Poll Merino	-3.40	-3.54	-1.27	-2.67
s6013322004000WD2	Poll Merino	-3.71	-1.07	-1.98	-2.50
s6013562007000449	Poll Merino	-2.27	-0.79	-1.03	-2.45
s6013652006060052	Poll Merino	-1.87	-0.56	-0.39	-0.86
s6090542006066533	Poll Merino	1.71	1.69	0.19	0.66
s6091542004040062	Poll Merino	0.38	-1.33	-0.10	-0.44

Table 21.1: Topside BLUP Estimates for the Sires, Without Covariates

Sire	Breed	Tender	Juicy	Flavour	Overall

s020041200707J039	Border Leicester	2.37	1.35	0.78	1.27
s020041200707J040	Border Leicester	-3.54	-1.57	-1.57	-1.99
s0219292007070261	Border Leicester	-3.89	-2.71	-1.39	-2.14
s0244112006060369	Border Leicester	1.13	1.21	1.71	1.37
s0246862007070179	Border Leicester	-3.25	-2.16	-1.53	-2.24
s0300182004045220	Corriedale	-3.50	-1.73	-1.53	-2.20
s0300362005050134	Corriedale	1.01	-0.05	0.85	1.10
s0315272003030360	Corriedale	-2.91	-2.37	-0.09	-1.43
s0318972006060386	Corriedale	-3.62	-1.73	-1.34	-2.01
s0600032006060121	Bond	-2.37	-1.35	-0.78	-1.27
s1500152003030196	Coopworth	-3.64	-2.05	-1.87	-2.65
s1500292007070244	Coopworth	-2.51	-0.80	0.13	-1.17
s1500392006061009	Coopworth	-1.22	-1.62	-0.38	-0.19
s1500482007070769	Coopworth	-2.20	-1.11	-0.31	-0.73
s1500622006060070	Coopworth	-1.36	-0.77	-0.53	-0.58
s1600012008080010	Poll Dorset	-1.68	-1.32	-0.92	-1.60
s1601852007070369	Poll Dorset	-1.26	-0.21	-0.31	-0.74
s1611432007070025	Poll Dorset	-2.75	-2.08	-1.16	-1.94
s1611582007070190	Poll Dorset	-3.69	-2.12	-0.93	-1.70
s1612352007072025	Poll Dorset	-3.10	-2.21	-1.56	-1.62
s1614152007070440	Poll Dorset	-3.98	-2.49	-1.74	-2.03
s1618922006060050	Poll Dorset	-2.78	-1.57	-1.10	-1.53
s1619722006061831	Poll Dorset	1.34	0.91	1.78	1.83
s1622882007070644	Poll Dorset	-1.91	-1.05	0.58	0.51
s1623682007070468	Poll Dorset	-2.65	-1.51	-1.68	-2.21
s1636772007070839	Poll Dorset	-6.64	-4.12	-2.91	-4.35
s1637212007070311	Poll Dorset	2.47	1.17	1.71	1.85

s1640732007070364	Poll Dorset	-4.48	-1.12	-1.35	-2.20
s1700622007070144	Texel	-3.03	-1.38	-1.35	-2.36
s1700802007071532	Texel	-0.26	-0.31	-0.48	0.28
s1702232007070046	Texel	-3.63	-1.63	-0.69	-1.85
s1704062007070028	Texel	-1.46	-2.02	-0.45	-1.13
s1704202007070224	Texel	-3.47	-1.41	-0.95	-1.30
s1900282007071494	Suffolk	-1.74	-1.32	-0.36	-1.06
s1900602007070267	Suffolk	-3.34	-2.24	-1.56	-2.13
s1901112007077058	Suffolk	-1.40	-0.99	-0.50	-0.56
s1918502001010120	Suffolk	-2.59	-1.04	-0.53	-1.22
s1920452007070508	Suffolk	-2.72	-1.10	-0.88	-1.34
s2300022007070098	White Suffolk	-2.19	-2.14	-0.10	-0.57
s2300092007070279	White Suffolk	-1.49	-0.67	-0.21	-0.35
s2300152007070143	White Suffolk	-1.28	-1.27	-0.18	-0.63
s2300262005050650	White Suffolk	-5.26	-2.25	-1.66	-2.86
s2300262007072446	White Suffolk	0.29	-0.41	-0.04	0.01
s2300342007074914	White Suffolk	-0.65	-0.32	-0.58	-0.54
s2300432007070591	White Suffolk	-4.58	-1.37	-1.86	-3.03
s2300912007070008	White Suffolk	-3.98	-2.29	-1.35	-1.94
s2301132007070040	White Suffolk	-4.32	-2.02	-2.48	-3.83
s2303182008080262	White Suffolk	-2.00	-1.33	-0.05	-0.56
s2303242007075630	White Suffolk	-2.93	-1.81	-1.47	-1.24
s2304502007071456	White Suffolk	-1.26	-0.73	0.18	-0.47
s4800302008080078	Prime Samm	-1.77	-0.99	-0.62	-1.41
s4800392007070062	Prime Samm	-2.75	-0.91	-0.29	-0.97
s4800552007070068	Prime Samm	-2.26	-1.69	-0.46	-0.70
s4800872006060421	Prime Samm	-3.77	-1.21	-0.73	-1.55

s4800992006060191	Prime Samm	-1.68	-1.75	-1.66	-1.84
s5000482007070260	Merino	-1.48	-0.97	0.04	-0.38
s5000872006060096	Merino	0.45	0.62	-0.05	0.73
s5007882007071254	Merino	1.78	0.82	1.61	1.19
s5018852006TRIMPH	Merino	-1.49	-1.33	0.52	0.28
s5024252006023997	Merino	0.63	-0.27	-0.31	-0.35
s5030542004040585	Merino	-4.52	-2.06	-1.60	-1.61
s5030972005051737	Merino	-4.79	-2.26	-3.21	-3.37
s5034252006060205	Merino	-4.05	-1.21	-1.24	-2.44
s5037892007LB0753	Merino	-4.33	-2.87	-1.89	-3.12
s5038632006OL3626	Merino	-1.17	-0.22	0.27	0.99
s5039462007OLY716	Merino	0.58	0.18	-0.21	0.09
s5039822006060225	Merino	0.15	-0.38	-0.44	-0.01
s5044702006060022	Merino	-4.85	-1.88	-1.62	-2.21
s5046152004040024	Merino	-1.57	-1.25	-0.07	-0.73
s5047432000000503	Merino	-2.41	-0.92	0.21	-0.50
s5049022005005345	Merino	-2.68	-2.46	-1.07	-1.59
s5049162007070719	Merino	-5.21	-2.72	-1.82	-2.56
s50923420060C0573	Merino	-1.10	-1.01	-0.67	-2.05
s5100032007070949	Dohne Merino	-6.87	-3.17	-1.58	-4.59
s5100092007070376	Dohne Merino	-3.72	-1.79	-1.52	-2.36
s5100302005050068	Dohne Merino	-2.63	-1.72	-0.01	-0.72
s5100492007071700	Dohne Merino	-2.84	-1.69	-1.39	-2.35
s5101402006060368	Dohne Merino	-2.48	-1.47	-1.08	-1.80
s6004082007070069	Poll Merino	-4.27	-1.77	-0.64	-1.60
s6005532007070002	Poll Merino	-2.12	-0.84	-0.34	-0.43
s6005712006060058	Poll Merino	0.50	-0.83	-0.31	0.25

s6008152006060120	Poll Merino	-2.35	-1.05	-0.07	-0.83
s6010532003031078	Poll Merino	-2.95	-1.38	-0.84	-0.94
s6010822007071257	Poll Merino	-1.66	-0.39	-0.92	-1.25
s6011272007070121	Poll Merino	-2.04	-1.55	-1.03	-1.02
s6012502004407812	Poll Merino	-2.14	-2.04	-1.08	-1.73
s6012882006063091	Poll Merino	-0.77	-0.94	-0.59	-0.56
s6013072005050165	Poll Merino	-2.31	-2.28	-0.92	-1.97
s6013162007070023	Poll Merino	-2.63	-3.34	-3.54	-3.54
s6013322004000WD2	Poll Merino	-3.42	-1.17	-0.50	-0.64
s6013562007000449	Poll Merino	-4.29	-1.04	0.70	-0.87
s6013652006060052	Poll Merino	-0.91	-0.34	-0.56	0.26
s6090542006066533	Poll Merino	-1.23	-0.62	0.96	-0.30
s6091542004040062	Poll Merino	4.88	1.42	1.53	0.88

Table 22.1: Loin Sire Ranks for the EQ Variables, With and Without Covariates

Sire Number	Breed	Tender Rank without covariate	Tender Rank with covariate	Juicy Rank Without covariate	Juicy Rank With covariate	Flavour Rank Without covariate	Flavour Rank With covariate
s020041200707J039	Border Leicester	94	93	80	92	88	94
s020041200707J040	Border Leicester	54	14	40	25	33	11
s0219292007070261	Border Leicester	13	52	38	41	30	75
s0244112006060369	Border Leicester	72	64	81	78	59	72
s0246862007070179	Border Leicester	32	43	9	56	36	51
s0300182004045220	Corriedale	28	78	31	51	28	23
s0300362005050134	Corriedale	81	44	90	57	89	71
s0315272003030360	Corriedale	56	1	30	2	5	24
s0318972006060386	Corriedale	17	83	16	27	25	50
s0600032006060121	Bond	45	58	47	74	42	56
s1500152003030196	Coopworth	26	76	29	44	37	34
s1500292007070244	Coopworth	65	46	70	9	54	58
s1500392006061009	Coopworth	67	71	43	91	80	90
s1500482007070769	Coopworth	11	6	20	21	11	33
s1500622006060070	Coopworth	77	65	73	75	66	60
s1600012008080010	Poll Dorset	80	42	60	40	84	27
s1601852007070369	Poll Dorset	23	40	36	49	18	47
s1611432007070025	Poll Dorset	24	82	17	83	50	86
s1611582007070190	Poll Dorset	38	49	68	85	55	79
s1612352007072025	Poll Dorset	44	61	8	8	6	10
s1614152007070440	Poll Dorset	9	3	12	12	12	4
s1618922006060050	Poll Dorset	87	90	77	76	79	66

s1619722006061831	Poll Dorset	92	11	94	43	92	35
s1622882007070644	Poll Dorset	88	8	93	58	93	20
s1623682007070468	Poll Dorset	5	55	4	46	7	45
s1636772007070839	Poll Dorset	1	36	2	52	1	9
s1637212007070311	Poll Dorset	89	66	89	53	87	73
s1640732007070364	Poll Dorset	22	28	46	6	34	12
s1700622007070144	Texel	47	77	32	87	17	85
s1700802007071532	Texel	85	34	86	37	73	69
s1702232007070046	Texel	3	57	5	31	10	31
s1704062007070028	Texel	68	51	58	72	53	81
s1704202007070224	Texel	33	59	55	39	81	19
s1900282007071494	Suffolk	34	50	44	45	49	42
s1900602007070267	Suffolk	25	21	24	22	40	17
s1901112007077058	Suffolk	51	81	72	30	52	8
s1918502001010120	Suffolk	53	67	42	84	31	64
s1920452007070508	Suffolk	57	73	37	29	35	29
s2300022007070098	White Suffolk	4	62	7	69	3	80
s2300092007070279	White Suffolk	60	80	76	82	43	70
s2300152007070143	White Suffolk	41	17	25	20	27	22
s2300262005050650	White Suffolk	90	12	88	67	91	28
s2300262007072446	White Suffolk	71	31	67	62	83	48
s2300342007074914	White Suffolk	76	53	83	11	38	37
s2300432007070591	White Suffolk	18	37	18	71	19	89
s2300912007070008	White Suffolk	31	41	39	17	23	14
s2301132007070040	White Suffolk	12	29	13	36	29	44
s2303182008080262	White Suffolk	79	85	84	61	90	77
s2303242007075630	White Suffolk	20	39	50	81	32	67

s2304502007071456	White Suffolk	62	63	22	68	47	59
s4800302008080078	Prime Samm	37	23	74	15	67	53
s4800392007070062	Prime Samm	74	74	78	7	57	21
s4800552007070068	Prime Samm	66	89	57	63	61	74
s4800872006060421	Prime Samm	49	16	61	13	24	6
s4800992006060191	Prime Samm	7	48	3	65	14	63
s5000482007070260	Merino	70	25	27	24	74	3
s5000872006060096	Merino	91	19	91	90	94	82
s5007882007071254	Merino	75	24	85	77	86	84
s5018852006TRIMPH	Merino	36	60	64	64	72	54
s5024252006023997	Merino	58	88	52	70	51	87
s5030542004040585	Merino	43	4	33	18	60	32
s5030972005051737	Merino	10	47	19	16	2	18
s5034252006060205	Merino	59	86	82	34	82	57
s5037892007LB0753	Merino	48	91	15	86	44	92
s5038632006OL3626	Merino	61	92	79	89	64	65
s5039462007OLY716	Merino	86	33	63	28	85	30
s5039822006060225	Merino	55	9	21	73	39	41
s5044702006060022	Merino	21	35	51	47	41	40
s5046152004040024	Merino	35	26	10	80	21	55
s5047432000000503	Merino	46	15	28	4	69	16
s5049022005005345	Merino	52	2	48	14	45	7
s5049162007070719	Merino	27	84	49	32	16	25
s50923420060C0573	Merino	83	20	87	59	70	43
s5100032007070949	Dohne Merino	2	38	6	33	9	36
s5100092007070376	Dohne Merino	39	22	69	35	46	26
s5100302005050068	Dohne Merino	6	70	14	60	8	49

s5100492007071700	Dohne Merino	30	69	65	54	56	78
s5101402006060368	Dohne Merino	40	75	71	42	58	38
s6004082007070069	Poll Merino	8	68	11	26	15	76
s6005532007070002	Poll Merino	73	87	62	93	22	61
s6005712006060058	Poll Merino	78	13	41	48	75	88
s6008152006060120	Poll Merino	63	54	66	55	65	83
s6010532003031078	Poll Merino	16	32	23	1	26	13
s6010822007071257	Poll Merino	14	18	59	3	77	15
s6011272007070121	Poll Merino	29	56	53	50	76	39
s6012502004407812	Poll Merino	82	27	75	88	62	93
s6012882006063091	Poll Merino	64	7	56	38	71	2
s6013072005050165	Poll Merino	69	30	35	79	68	46
s6013162007070023	Poll Merino	19	79	1	66	13	62
s6013322004000WD2	Poll Merino	15	72	34	94	4	91
s6013562007000449	Poll Merino	42	94	45	23	20	68
s6013652006060052	Poll Merino	50	45	54	5	48	1
s6090542006066533	Poll Merino	93	5	92	19	78	52
s6091542004040062	Poll Merino	84	10	26	10	63	5

Sire Number	Breed	Rank Overall Liking Without covariate	Rank Overall Liking With covariate
s020041200707J039	Border Leicester	93	94
s020041200707J040	Border Leicester	30	13
s0219292007070261	Border Leicester	22	60
s0244112006060369	Border Leicester	76	69
s0246862007070179	Border Leicester	46	57
s0300182004045220	Corriedale	34	29
s0300362005050134	Corriedale	86	76
s0315272003030360	Corriedale	4	7
s0318972006060386	Corriedale	20	61
s0600032006060121	Bond	42	43
s1500152003030196	Coopworth	31	41
s1500292007070244	Coopworth	50	47
s1500392006061009	Coopworth	74	92
s1500482007070769	Coopworth	18	20
s1500622006060070	Coopworth	72	44
s1600012008080010	Poll Dorset	81	32
s1601852007070369	Poll Dorset	16	34
s1611432007070025	Poll Dorset	48	87
s1611582007070190	Poll Dorset	39	79
s1612352007072025	Poll Dorset	5	22
s1614152007070440	Poll Dorset	6	6
s1618922006060050	Poll Dorset	77	77
s1619722006061831	Poll Dorset	94	59
s1622882007070644	Poll Dorset	92	35
s1623682007070468	Poll Dorset	11	28
s1636772007070839	Poll Dorset	1	14

s1637212007070311	Poll Dorset	89	74
s1640732007070364	Poll Dorset	57	11
s1700622007070144	Texel	23	90
s1700802007071532	Texel	82	56
s1702232007070046	Texel	7	31
s1704062007070028	Texel	49	78
s1704202007070224	Texel	65	18
s1900282007071494	Suffolk	41	54
s1900602007070267	Suffolk	45	23
s1901112007077058	Suffolk	43	15
s1918502001010120	Suffolk	37	58
s1920452007070508	Suffolk	38	46
s2300022007070098	White Suffolk	2	84
s2300092007070279	White Suffolk	51	71
s2300152007070143	White Suffolk	36	17
s2300262005050650	White Suffolk	90	42
s2300262007072446	White Suffolk	78	52
s2300342007074914	White Suffolk	67	24
s2300432007070591	White Suffolk	15	81
s2300912007070008	White Suffolk	29	16
s2301132007070040	White Suffolk	25	49
s2303182008080262	White Suffolk	85	83
s2303242007075630	White Suffolk	32	73
s2304502007071456	White Suffolk	47	53
s4800302008080078	Prime Samm	84	40
s4800392007070062	Prime Samm	62	19
s4800552007070068	Prime Samm	44	70

s4800872006060421	Prime Samm	33	12
s4800992006060191	Prime Samm	10	62
s5000482007070260	Merino	61	5
s5000872006060096	Merino	91	80
s5007882007071254	Merino	80	68
s5018852006TRIMPH	Merino	69	51
s5024252006023997	Merino	54	82
s5030542004040585	Merino	59	37
s5030972005051737	Merino	3	10
s5034252006060205	Merino	71	48
s5037892007LB0753	Merino	28	91
s5038632006OL3626	Merino	63	88
s5039462007OLY716	Merino	79	38
s5039822006060225	Merino	26	39
s5044702006060022	Merino	40	63
s5046152004040024	Merino	17	66
s5047432000000503	Merino	75	21
s5049022005005345	Merino	56	2
s5049162007070719	Merino	21	26
s50923420060C0573	Merino	88	45
s5100032007070949	Dohne Merino	13	30
s5100092007070376	Dohne Merino	60	27
s5100302005050068	Dohne Merino	9	64
s5100492007071700	Dohne Merino	52	72
s5101402006060368	Dohne Merino	53	25
s6004082007070069	Poll Merino	19	50
s6005532007070002	Poll Merino	35	85

s6005712006060058	Poll Merino	66	89
s6008152006060120	Poll Merino	55	86
s6010532003031078	Poll Merino	24	8
s6010822007071257	Poll Merino	27	9
s6011272007070121	Poll Merino	73	55
s6012502004407812	Poll Merino	83	75
s6012882006063091	Poll Merino	70	4
s6013072005050165	Poll Merino	64	33
s6013162007070023	Poll Merino	8	67
s6013322004000WD2	Poll Merino	12	93
s6013562007000449	Poll Merino	14	65
s6013652006060052	Poll Merino	58	3
s6090542006066533	Poll Merino	87	36
s6091542004040062	Poll Merino	68	1

Table 23.1: Topside Sire Ranks for the EQ Variables, With and Without Covariates

Sire Number	Breed	Tender Rank without covariate	Tender Rank with covariate	Juicy Rank Without covariate	Juicy Rank With covariate	Flavour Rank Without covariate	Flavour Rank With covariate
s020041200707J039	Border Leicester	92	93	93	93	87	56
s020041200707J040	Border Leicester	24	14	37	8	16	15
s0219292007070261	Border Leicester	17	52	6	55	23	34
s0244112006060369	Border Leicester	89	64	92	68	93	75
s0246862007070179	Border Leicester	29	43	16	18	19	52
s0300182004045220	Corriedale	25	78	31	82	20	79
s0300362005050134	Corriedale	88	44	86	44	88	42
s0315272003030360	Corriedale	34	1	9	1	72	1
s0318972006060386	Corriedale	23	83	30	65	28	65
s0600032006060121	Bond	48	58	46	86	43	48
s1500152003030196	Coopworth	21	76	21	66	6	81
s1500292007070244	Coopworth	45	46	72	20	80	25
s1500392006061009	Coopworth	75	71	36	78	60	77
s1500482007070769	Coopworth	52	6	57	5	63	7
s1500622006060070	Coopworth	70	65	73	84	53	69
s1600012008080010	Poll Dorset	61	42	50	12	39	30
s1601852007070369	Poll Dorset	72	40	85	37	66	21
s1611432007070025	Poll Dorset	37	82	19	89	30	87
s1611582007070190	Poll Dorset	20	49	18	38	37	64
s1612352007072025	Poll Dorset	30	61	15	58	18	46
s1614152007070440	Poll Dorset	15	3	7	4	9	5
s1618922006060050	Poll Dorset	36	90	38	91	31	90

s1619722006061831	Poll Dorset	90	11	90	61	94	27
s1622882007070644	Poll Dorset	58	8	60	23	85	19
s1623682007070468	Poll Dorset	41	55	40	57	10	41
s1636772007070839	Poll Dorset	2	36	1	21	3	26
s1637212007070311	Poll Dorset	93	66	91	42	92	61
s1640732007070364	Poll Dorset	9	28	56	41	27	49
s1700622007070144	Texel	31	77	43	60	26	76
s1700802007071532	Texel	81	34	82	46	56	37
s1702232007070046	Texel	22	57	35	54	45	66
s1704062007070028	Texel	68	51	24	24	58	23
s1704202007070224	Texel	26	59	42	49	36	62
s1900282007071494	Suffolk	60	50	49	79	61	60
s1900602007070267	Suffolk	28	21	14	9	17	29
s1901112007077058	Suffolk	69	81	65	75	55	91
s1918502001010120	Suffolk	44	67	62	85	52	73
s1920452007070508	Suffolk	39	73	58	59	41	72
s2300022007070098	White Suffolk	53	62	17	51	71	67
s2300092007070279	White Suffolk	65	80	75	77	68	54
s2300152007070143	White Suffolk	71	17	51	52	70	11
s2300262005050650	White Suffolk	3	12	13	31	11	31
s2300262007072446	White Suffolk	83	31	77	27	77	40
s2300342007074914	White Suffolk	80	53	81	35	50	20
s2300432007070591	White Suffolk	7	37	45	48	7	44
s2300912007070008	White Suffolk	16	41	10	22	25	33
s2301132007070040	White Suffolk	11	29	23	40	4	28
s2303182008080262	White Suffolk	57	85	47	81	75	85
s2303242007075630	White Suffolk	33	39	26	53	22	58

s2304502007071456	White Suffolk	73	63	74	64	81	68
s4800302008080078	Prime Samm	59	23	64	32	48	12
s4800392007070062	Prime Samm	38	74	69	47	67	55
s4800552007070068	Prime Samm	51	89	34	90	57	82
s4800872006060421	Prime Samm	18	16	54	45	44	14
s4800992006060191	Prime Samm	62	48	29	34	12	32
s5000482007070260	Merino	67	25	66	26	79	2
s5000872006060096	Merino	84	19	88	76	76	22
s5007882007071254	Merino	91	24	89	36	91	57
s5018852006TRIMPH	Merino	66	60	48	50	84	47
s5024252006023997	Merino	87	88	83	83	65	78
s5030542004040585	Merino	8	4	20	25	14	16
s5030972005051737	Merino	6	47	12	43	2	35
s5034252006060205	Merino	14	86	53	74	29	89
s5037892007LB0753	Merino	10	91	4	88	5	94
s5038632006OL3626	Merino	76	92	84	94	83	93
s5039462007OLY716	Merino	86	33	87	6	69	24
s5039822006060225	Merino	82	9	79	10	59	17
s5044702006060022	Merino	5	35	25	29	13	39
s5046152004040024	Merino	64	26	52	33	73	36
s5047432000000503	Merino	47	15	68	7	82	13
s5049022005005345	Merino	40	2	8	11	34	70
s5049162007070719	Merino	4	84	5	71	8	83
s50923420060C0573	Merino	77	20	63	16	46	8
s5100032007070949	Dohne Merino	1	38	3	56	15	38
s5100092007070376	Dohne Merino	19	22	27	13	21	74
s5100302005050068	Dohne Merino	42	70	32	67	78	59

s5100492007071700	Dohne Merino	35	69	33	62	24	50
s5101402006060368	Dohne Merino	46	75	41	72	33	84
s6004082007070069	Poll Merino	13	68	28	70	47	51
s6005532007070002	Poll Merino	55	87	70	63	62	80
s6005712006060058	Poll Merino	85	13	71	19	64	9
s6008152006060120	Poll Merino	49	54	59	39	74	45
s6010532003031078	Poll Merino	32	32	44	3	42	3
s6010822007071257	Poll Merino	63	18	78	14	40	6
s6011272007070121	Poll Merino	56	56	39	69	35	71
s6012502004407812	Poll Merino	54	27	22	28	32	43
s6012882006063091	Poll Merino	79	7	67	30	49	18
s6013072005050165	Poll Merino	50	30	11	73	38	88
s6013162007070023	Poll Merino	43	79	2	87	1	63
s6013322004000WD2	Poll Merino	27	72	55	80	54	86
s6013562007000449	Poll Merino	12	94	61	92	86	92
s6013652006060052	Poll Merino	78	45	80	15	51	53
s6090542006066533	Poll Merino	74	5	76	2	89	4
s6091542004040062	Poll Merino	94	10	94	17	90	10

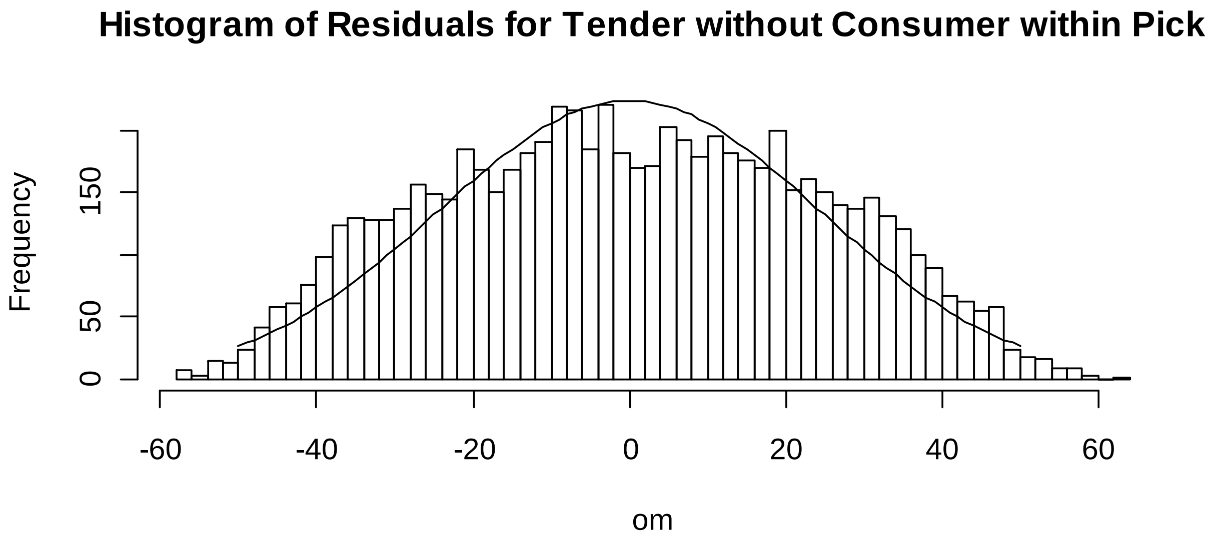
Sire Number	Breed	Rank Overall Liking Without covariate	Rank Overall Liking With covariate
s020041200707J039	Border Leicester	91	91
s020041200707J040	Border Leicester	25	16
s0219292007070261	Border Leicester	20	39
s0244112006060369	Border Leicester	92	64
s0246862007070179	Border Leicester	15	54
s0300182004045220	Corriedale	18	81
s0300362005050134	Corriedale	89	57
s0315272003030360	Corriedale	41	1
s0318972006060386	Corriedale	24	62
s0600032006060121	Bond	45	44
s1500152003030196	Coopworth	9	71
s1500292007070244	Coopworth	49	29
s1500392006061009	Coopworth	77	75
s1500482007070769	Coopworth	58	10
s1500622006060070	Coopworth	64	69
s1600012008080010	Poll Dorset	36	52
s1601852007070369	Poll Dorset	57	35
s1611432007070025	Poll Dorset	28	90
s1611582007070190	Poll Dorset	33	61
s1612352007072025	Poll Dorset	34	46
s1614152007070440	Poll Dorset	23	2
s1618922006060050	Poll Dorset	40	92
s1619722006061831	Poll Dorset	93	24
s1622882007070644	Poll Dorset	85	9
s1623682007070468	Poll Dorset	16	34
s1636772007070839	Poll Dorset	2	42

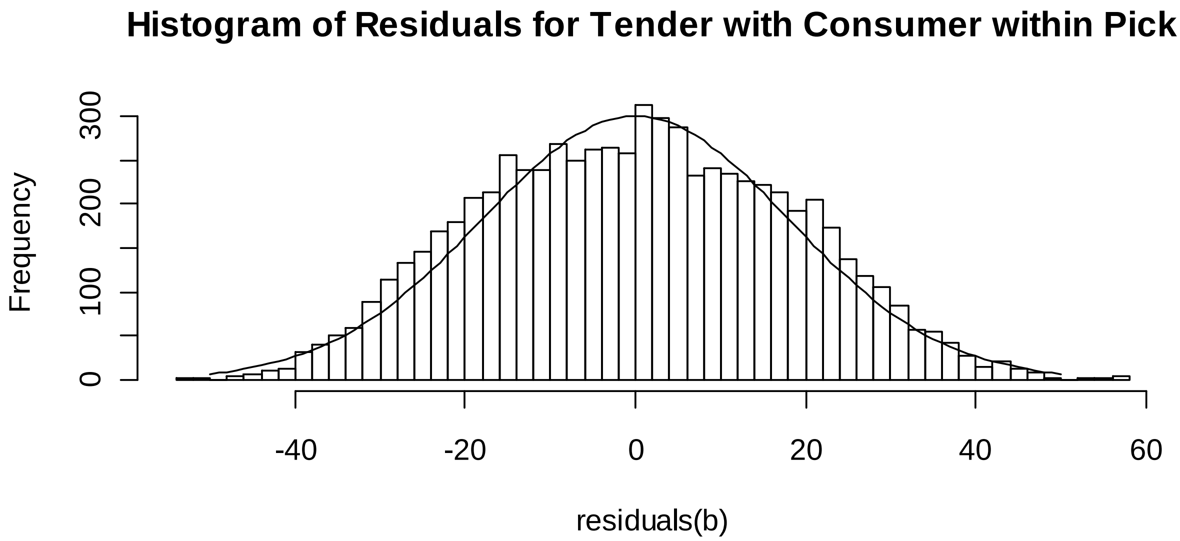
s1637212007070311	Poll Dorset	94	73
s1640732007070364	Poll Dorset	19	30
s1700622007070144	Texel	13	77
s1700802007071532	Texel	83	47
s1702232007070046	Texel	29	53
s1704062007070028	Texel	50	40
s1704202007070224	Texel	44	59
s1900282007071494	Suffolk	51	66
s1900602007070267	Suffolk	21	23
s1901112007077058	Suffolk	67	86
s1918502001010120	Suffolk	48	70
s1920452007070508	Suffolk	43	74
s2300022007070098	White Suffolk	65	60
s2300092007070279	White Suffolk	75	67
s2300152007070143	White Suffolk	63	17
s2300262005050650	White Suffolk	8	5
s2300262007072446	White Suffolk	79	43
s2300342007074914	White Suffolk	69	21
s2300432007070591	White Suffolk	7	37
s2300912007070008	White Suffolk	27	48
s2301132007070040	White Suffolk	3	33
s2303182008080262	White Suffolk	68	80
s2303242007075630	White Suffolk	47	50
s2304502007071456	White Suffolk	71	68
s4800302008080078	Prime Samm	42	11
s4800392007070062	Prime Samm	53	63
s4800552007070068	Prime Samm	61	87

s4800872006060421	Prime Samm	39	25
s4800992006060191	Prime Samm	30	31
s5000482007070260	Merino	73	7
s5000872006060096	Merino	86	20
s5007882007071254	Merino	90	38
s5018852006TRIMPH	Merino	84	65
s5024252006023997	Merino	74	85
s5030542004040585	Merino	35	13
s5030972005051737	Merino	5	49
s5034252006060205	Merino	11	88
s5037892007LB0753	Merino	6	94
s5038632006OL3626	Merino	88	93
s5039462007OLY716	Merino	80	28
s5039822006060225	Merino	78	26
s5044702006060022	Merino	17	12
s5046152004040024	Merino	59	27
s5047432000000503	Merino	70	14
s5049022005005345	Merino	38	18
s5049162007070719	Merino	10	83
s50923420060C0573	Merino	22	3
s5100032007070949	Dohne Merino	1	36
s5100092007070376	Dohne Merino	12	51
s5100302005050068	Dohne Merino	60	79
s5100492007071700	Dohne Merino	14	56
s5101402006060368	Dohne Merino	31	82
s6004082007070069	Poll Merino	37	58
s6005532007070002	Poll Merino	72	76

s6005712006060058	Poll Merino	81	22
s6008152006060120	Poll Merino	56	32
s6010532003031078	Poll Merino	54	8
s6010822007071257	Poll Merino	46	15
s6011272007070121	Poll Merino	52	55
s6012502004407812	Poll Merino	32	45
s6012882006063091	Poll Merino	66	41
s6013072005050165	Poll Merino	26	78
s6013162007070023	Poll Merino	4	84
s6013322004000WD2	Poll Merino	62	72
s6013562007000449	Poll Merino	55	89
s6013652006060052	Poll Merino	82	19
s6090542006066533	Poll Merino	76	4
s6091542004040062	Poll Merino	87	6

Figure 1.1. Comparison of the Residuals With, and Without the Consumer Random Effect being Included in the Statistical Model. A Normal Distribution is overlaid on each Histogram





Milestone 2

The Effect of Consumers Having Different References for EQ Scores

Figure 1.2 shows a histogram of the least squares estimates for the EQ variable Overall Liking for each consumer within pick for the Loin. The x - axis represents least squares means for Overall Liking for the individual consumers. It is clear that there are no distinct groups of consumers represented by an identifiable “cut off”. Rather there is a continuum of response of consumer judgement where there is a smooth decreasing frequency of a reference scale for EQ judgement. In particular, there is no clear point of truncation that makes the population consumer response more symmetrical.

An important question to address is whether these consumer evaluations are consistent. For example, does a consumer that rates tenderness lower than the bulk of consumers (i.e. is a member of the asymmetric tail of the distribution) also rate juiciness, flavour and overall liking lower. Importantly is this consumers star rating also consistent with the ratings of the other EQ variables. This problem is addressed by fitting the consumer within pick to the ratios of the scores of the EQ variables If there were large significant consumer differences in these ratios this would be an indication that there was no consistency in the reference points within a consumer. That is, there would be no proportionality in how a consumer scored each of the EQ variables for a given meat sample. To clarify the purpose of this analysis suppose for 2 hypothetical consumers tasting the same meat one scored tenderness as 60 and juicy as 50, while the second scored tenderness as 70 and juiciness as 58. The numbers are different but the relative proportions are the same. This infers that while the consumers are using different scores their scales to differentiate the meat are the same. So, if there are significant numbers of consumers who are using different EQ reference points (which we have identified), but are also using different scales as evidenced by significantly different proportional ratios of the EQ variables, then a test for consumer differences in the EQ ratios will show this. Out of about 7500 evaluations there were only 10 that showed significant deviations in the EQ variable ratios (after Bonferroni correction). These are the ones that might be deemed rogue consumers, delivering inconsistent judgements. This number was so small that it would not affect the results of the analysis. That is, the analysis shows that while consumers have different EQ variable scoring reference points, they are consistent in their reporting of the scale of those variables. Different consumers rate the same meat quality in the same proportion, so an analysis can ignore differences in EQ variable reference points. Indeed, the extremely low cases where the consumer responses were not proportional could very likely be due to a poor meat sample. However, if this was the case the low incidence is a credit to the care given to the preparation of the meat samples.

Further evidence of within consumer consistency is given in Table 1.2 which shows that the relationships between the EQ variables and the star rating are not materially altered by removing the consumer effect. That is, if a consumer deviated from the bulk of the other consumers in their evaluation of an EQ variable then they showed a similar deviation for the star rating.

These 2 analyses suggest that all the relationships are proportional and a reliable discriminant function can be constructed. Thus, this analysis will ignore this issue of consumers having different reference points, assuming that that each consumer adjusts each score to the same proportion, enabling consistent estimators of the relationships between the consumer scores and the evaluation of the star category.

Discriminant Analysis for the Effect of EQ Variable on Star Eating Quality Category

Table 2.2a shows the coefficients for the discriminant function for classifying the star rating based on the 4 EQ variables for the Loin. Table 2.2b shows the coefficients for the Topside, which required a quadratic term in Overall Liking to discriminant the star category correctly. Table 3.2 shows the numbers of correctly and incorrectly classified variables and their percentages using the discriminant function in Table 2.2, The best linear discriminant function would thus miss classify 17% of the star 4 Loin cuts as star 5 and 19% of the Loin cuts as the lower star 3. Similarly 32% of the star 5 Loin cuts would be miss classified to a lower star rating. Using principal component scores instead of the actual variables did not improve this prediction. It is notable that there is poorer identification of meat cuts classified as star 4 in the Topside than in the Loin.

Using Overall Liking as a single discriminant variable for star rating gives a discriminant coefficient of 0.0848 for this single EQ variable for the Loin. For Topside the quadratic function was 0.8197(Overall Liking) + 0.1803(Overall Liking)^2. The classification accuracy of this strategy is given in Table 4.2a for the Loin and Table 4.2b for the Topside. It is clear that the consideration of the EQ variables tender, juicy and flavour adds nothing to the discrimination power of overall liking applied alone for the Loin. This result is consistent with the larger coefficient for Overall Liking in the linear discriminant function shown in Table 2.2. However, for the Topside a considerable degradation of predictive performance occurs for discriminating star categories 4 and 5.

The result of excluding Overall Liking from the discriminant function that is using only tender juicy and flavour, is shown in Table 5a for the Loin and Table 5.2b for the Topside. The accuracy of prediction for the Loin using only the 3 EQ variables is very similar to that of using all 4 EQ variables or just Overall Liking alone. This suggests that the EQ variables tender, juicy and flavour could be used to discriminate the star category of the Loin cut without reference to Overall Liking, which is harder to define. The Topside shows much poorer prediction for star categories 4 and 5 when either Overall Liking is used as a single (quadratic) predictor, or if tender, juicy and flavour are used without Overall Liking compared with using all EQ variables.

Discrimination for Different Sire Breeds

The accuracy of discrimination of star category through the EQ variables for each of the sire breeds in the trial is given in Table 6a for the Loin and Table 6.2b for the Topside. The poor discrimination into star categories 4 and 5 for the Topside may reflect the lower numbers in these categories contributing to the discriminant function.

Discrimination for Different Dam Breeds

The accuracy of discrimination of star category through the EQ variables for the 2 dam breed is given in Table 7.2a for the Loin and Table 7.2b for the Topside. These results are more consistent with the full analysis than the results for the sire breeds, probably due to the higher numbers involved. There was no significant effect of the dam.

Testing 2 Stage Discrimination for Improving Allocation to Premium Meat Quality

. A 2 stage discriminant analysis was tested to see if the error rates for the 4 and 5 star categories could be improved.. This analysis takes the meat allocated to star 4 by the first discriminant function and then seeks a second discrimination of this meat that partitions it into meat that is 5 star and meat that is 4 star or less. However, this procedure was not able to improve the prediction of the star rating from the values of the EQ variables.

Forcing Overall Liking to Have Less Influence on Meat Quality Discrimination

Forcing Overall Liking to have a coefficient in the discriminant function that is 40% of the influence of the other variables (tender, juicy, flavour) can be accomplished by dividing the Overall Liking score by a factor of 0.35. However, this makes no difference to the discrimination accuracy (it is the same as if no change was made to Overall Liking). If the goal is to reduce the influence of Overall Liking on the discrimination procedure then an option is to “blur” the information in this variable by rounding its value to be a multiple of 10. This reduces the contribution of Overall Liking to 58% from 69% of the discriminant function for the Loin. It had no effect on the accuracy of the star category prediction in Tables 3a and 3b.

An alternative approach is to remove all the covariance from Overall Liking associated with the EQ variables tender, juicy and flavour through a regression of Overall Liking on these variables. The residuals from this analysis are then used in place of the Overall Liking scores. This procedure gives almost the same predictions for the star categories as Table 3, but the discriminant coefficients for the Loin are now 0.0222(tender); 0.0150(juicy); 0.0512(flavour); 0.0612(Overall Liking). In this case the coefficient for Overall Liking gives 41% of the weight to the discriminant function.

Multinomial Logit Analysis of Discrimination

An alternative analysis to discriminant functions is to use logit analyses to find a discriminating relationship between the star categories based on the EQ variables. This analysis has better properties, being less dependent on covariance structure.

The multinomial logit estimates for the effect of the EQ variables on the star categories are shown in Table 8a for the Loin and Table 8b for the Topside.

To calculate the probabilities of a meat sample being in a given star rating given the values of the EQ variables tender, juicy, flavour and overall liking the procedure is:

1. Calculate exp(Intercept + b_1 tender + b_2 juicy + b_3 flavour + b_4 overall liking) for each of the 3 logit regression in Table 7. For example, for tender = 60; juicy = 70; flavour = 65 and overall liking = 70 then for star 3 exp(-4.9361 + 0.0064 x 60 + 0.0059 x 70 + 0.0273 x 65 + 0.0962 x 70) = 78.9962
2. Sum these results for each star rating case. 78.9962 + 54.7293 + 2.4473 = 136.1729
3. The probability of being in the reference star rating (star 2) given the values for the EQ variables is $\frac{1}{1+136.1729}$ = 0.007.

4. The probability of being in each of the other star rating is the value of exp(regression) as calculated in item (1) divided by 1 + the sum. For the probability of the example being in start 3 this is $\frac{78.9962}{1+136.1729}$ = 0.58. Similar calculations for show that the probability of being in star 4 is 0.40, and in star 5 is 0.02 for the given values of the EQ variables.

These calculations are best coded into a computer program which can then calculate the probabilities of being in a particular star category given the values of the EQ variables. The star category having the highest estimated probability would be the category within which the meat would be allocated. This procedure has the advantage of showing easily when there is a significant probability of the meat being in a different star category. For example given a set of EQ variables the probability of the meat being star 4 might be 52% and 48% of being star 5. The meat would be allocated to star 4 because this has the highest estimated probability, but note the strong contention that it is star category 5.

Moderation of Tender by Flavour

If flavour moderates the judgement of tenderness in allocating a star rating then this would be expected to be expressed as a significant interaction of tender and flavour in the multinomial logit calculation. However, a calculation shows that there is no significant interaction between tender and flavour in discriminating the eating quality of sheep meat as measured by the star rating.

The lack of interaction between tender and flavour in influencing the star category is further illustrated in Figure 2.2, which shows the result of fitting a generalised additive model smoother. The plot shows no evidence of departure from an additive effect of both variables. This smoother analysis appears to rule out the existence of some complicated functional relationship of tender and flavour on the star category.

Discussion

The use of a discriminant function to allocate meat to each of 4 meat quality star categories (2 to 5 star) appears to work well, giving between 60% and 70% of correct star category allocations. The exception is the prediction of star 4 samples in the Topside cut. In this respect the issues noted with consumers having different reference frames, and also the propensity of some consumers to round up their scores so that there are higher frequencies of scores in the tens (50, 60, 70, 80, 90) suggests that little more accuracy can be gained, at least in terms of simple allocation strategies. The reliability of any discriminant function is limited by the accuracy of the consumer evaluations. This problem is illustrated by Figure 3 which shows the variation for Overall Liking within consumer. The large amount of variation is notable, and the effect of this variation on the limiting the accuracy of any discriminant function based on the EQ variables is clear. An improvement in the predictability of meat quality will have to use other information besides consumer evaluations.

The strategy for prediction applied here treats all errors the same across all star categories. This might not be the best strategy from a marketing perspective. It might be better to find a discrimination procedure that improves the error rates at the premium star categories at the risk of poorer allocation at the lower star categories. This is a question to address under the next milestone. One issue worth pursuing is to find some kind of second discrimination procedure that can be applied to further sort that meat allocated to the premium star categories with the aim of reducing the number of samples misclassified as premium. An attempt to do this by applying a second standard discrimination function did not work. But other strategies might. This is also a topic for the next milestone.

The analysis suggests that an adequate discrimination can be achieved by using either Overall Liking alone, or by using just tender, juicy and flavour without Overall Liking. Given that the EQ variables tender, juicy and flavour are more objective than Overall Liking this is a result worth noting

A discrimination strategy can be constructed using either discriminant analysis as in past analyses of meat quality, or using multinomial logits. Both provide very similar outcomes, however, logit analysis is more flexible, especially in dealing with interactions among the prediction variables, and also has fewer assumptions than discriminant analysis.

The disadvantage is that the calculation of the allocation of a sample is more complex, especially for multinomial logits (more than 2 categories to deal with) than binary logits (2 categories). However, this calculation can be automated into a “black box”.

As noted, logit analysis also gives the probabilities of a sample being in each of the categories of interest, and the standard errors of these probabilities are given. This enables an uncertainty to be associated with each probability calculation. This attribute may be useful in refining an allocation strategy, where for example the probabilities of a sample being in different categories are similar. For example, such a strategy might be to only allocate meat to a premium category if the probability of being in that category is e.g. higher than 0.6. This strategy would disqualify meat that had a 51% chance of being in the premium category (and would be so allocated) compared to a relatively high chance of being less than premium. These are issues for discussion with the people using this tool.

The complication of multinomial logit analysis has precluded its application to discriminant analysis previously. This situation has now been rectified, and suitable software is available.

Table 1.2: Correlations between the EQ variables and the star rating for the Loin for eating quality for the raw data and for the residuals after fitting consumer within pick as a fixed effects

EQ Variable	Raw data	Residuals after fitting consumer within pick
Tender	0.66	0.59
Juicy	0.67	0.60
Flavour	0.74	0.67
Overall Liking	0.79	0.72

Table 2.2a Star Rating Discriminant Function Coefficients for the Loin

EQ Variable	Discriminant Coefficient	Percentage
Tender	0.0097	11%
Juicy	0.0064	7%
Flavour	0.0118	13%
Overall Liking	0.0612	69%

Table 2.2b Star rating discriminant function coefficients for the Topside Quadratic Discriminant Function for Topside

EQ Variable	Quadratic Discriminant Coefficient	Percentage
Tender	-0.0128	29%
Juicy	-0.0019	4%
Flavour	-0.0046	11%
Overall Liking	-0.0240	55%
Overall Liking squared	-0.0003	1%

Table 3.2a: Number of correct and incorrect classifications of the star rating for the Loin for the Linear discriminant function given in Table 2a

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	357	187	2	0
Actual 3	172	1743	614	62
Actual 4	1	490	1663	452
Actual 5		30	554	1216

Percentages

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	65	34	1	0
Actual 3	7	67	24	2
Actual 4	0.	19	64	17
Actual 5	0	2	32	66

Table 3.2b: Number of correct and incorrect classifications of the star rating for the Topside for the discriminant function given in Table 2b.

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	1643	548	6	0
Actual 3	401	2743	424	44
Actual 4	9	471	561	209
Actual 5	0	32	106	252

Percentages

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	75	25	0	0
Actual 3	11	76	12	1

Actual 4	0	38	45	17
Actual 5	0	8	27	65

Table 4.2a: Numbers of correctly and incorrectly classified star categories and the percentages when using the EQ variable overall liking as the single discriminant variable for the Loin.

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	335	204	7	0
Actual 3	174	1712	633	72
Actual 4	4	542	1600	463
Actual 5		41	575	1184

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	61	37	2	0
Actual 3	7	66	24	3
Actual 4	0	21	61	18
Actual 5	0	2	32	66

Table 4.2b: Numbers of correctly and incorrectly classified star categories and the percentages when using the EQ variable overall liking as the single discriminant variable for the Topside.

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	1677	515	5	0
Actual 3	435	2792	361	24
Actual 4	8	546	603	9
3Actual 5	0	26	194	170

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	76	23	1	0
Actual 3	12	77	10	1
Actual 4	0	47	53	0
Actual 5	0	7	49	44

Table 5.2a: Number of correct and incorrect classifications of the star rating for the Loin for the Discriminant function based on Tender, Juicy and Flavour only.

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	274	269	3	0
Actual 3	130	1682	656	133
Actual 4	7	518	1266	815
Actual 5	1	46	358	1375

Percentages

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	50	50	0	
Actual 3	5	65	25	5
Actual 4	0	20	49	31
Actual 5	0	3	20	77

Table 5.2b: Number of correct and incorrect classifications of the star rating for the Topside for the Discriminant function based on Tender, Juicy and Flavour only.

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	1545	645	7	0
Actual 3	472	2727	381	32
Actual 4	8	543	537	162
Actual 5	1	40	124	225

Percentages

Star Rating	Estimated as 2	Estimated as 3	Estimated as 4	Estimated as 5
Actual 2	70	29	1	0
Actual 3	13	76	11	0
Actual 4	0	44	43	13
Actual 5	0	10	32	58

Table 6.2a: Percentage of correct predictions based on a discriminant function of all the EQ variables for the star rating for each of the sire breeds for the Loin

Sire Breed	Star 2	Star 3	Star4	Star 5
Bond	30	38	68	73
Border Leicester	45	66	73	47
Coopworth	72	60	67	66
Corriedale	75	72	66	79
Dohne Merino	80	73	63	75
Merino	84	58	62	74
Poll Dorset	68	72	65	61
Poll Merino	55	63	65	72
Prime Samm	76	62	59	78
Suffolk	63	64	56	77
White Suffolk	61	67	66	62
Texel	62	68	63	61

Table 6.2b: Percentage of correct predictions based on a discriminant function of all the EQ variables for the star rating for each of the sire breeds for the Topside

Sire Breed	Star 2	Star 3	Star4	Star 5
Bond	83	73	64	0
Border Leicester	73	71	50	67
Coopworth	77	77	32	64

Corriedale	75	71	61	47
Dohne Merino	79	75	24	68
Merino	77	78	47	45
Poll Dorset	74	74	42	68
Poll Merino	76	78	41	75
Prime Samm	67	76	50	53
Suffolk	71	71	36	68
White Suffolk	77	72	48	67
Texel	73	77	41	49

Table 7.2a: Percentage of correct predictions based on a discriminant function of all the EQ variables for the star rating for each of the dam breeds for the Loin

Dam Breed	Star 2	Star 3	Star4	Star 5
Merino	66	67	63	71
BLM	66	68	68	51

Table 7.2b: Percentage of correct predictions based on a discriminant function of all the EQ variables for the star rating for each of the dam breeds for the Topside

Dam Breed	Star 2	Star 3	Star4	Star 5
Merino	76	75	48	63
BLM	71	76	38	75

Table 8.2a: Multinomial logit estimates for the star rating depending on the EQ variables for the Loin. The reference is star 2.

Star rating	Intercept	tender	juicy	flavour	Overall liking
3	-4.9361 ± 0.2631	0.0064 ± 0.0038	0.0059 ± 0.0040	0.0273 ± 0.0058	0.0962 ± 0.0077
4	-13.5736 ± 0.3648	0.0265 ± 0.0046	0.0153 ± 0.0047	0.0354 ± 0.0069	0.1802 ± 0.0093
5	-27.0739 ± 0.5691	0.0496 ± 0.0064	0.0344 ± 0.0056	0.0572 ± 0.0090	0.2696 ± 0.0121

Table 8.2b: Multinomial logit estimates for the star rating depending on the EQ variables for the Topside. The reference is star 2.

Star rating	Intercept	tender	juicy	flavour	Overall liking
3	-5.3742 ± 0.1589	0.0166 ± 0.0026	0.0019 ± 0.0026	0.0089 ± 0.0032	0.1058 ± 0.0047
4	-13.7908 ± 0.3024	0.0417 ± 0.0038	0.0066 ± 0.0039	0.0147 ± 0.0055	0.1798 ± 0.0073

5	-26.3800 ± 0.7706	0.0704 ± 0.0075	0.0116 ± 0.0066	0.0408 ± 0.0125	0.2568 ± 0.0153

Figure 1.2. Frequency of Mean Consumer Score for Overall Liking

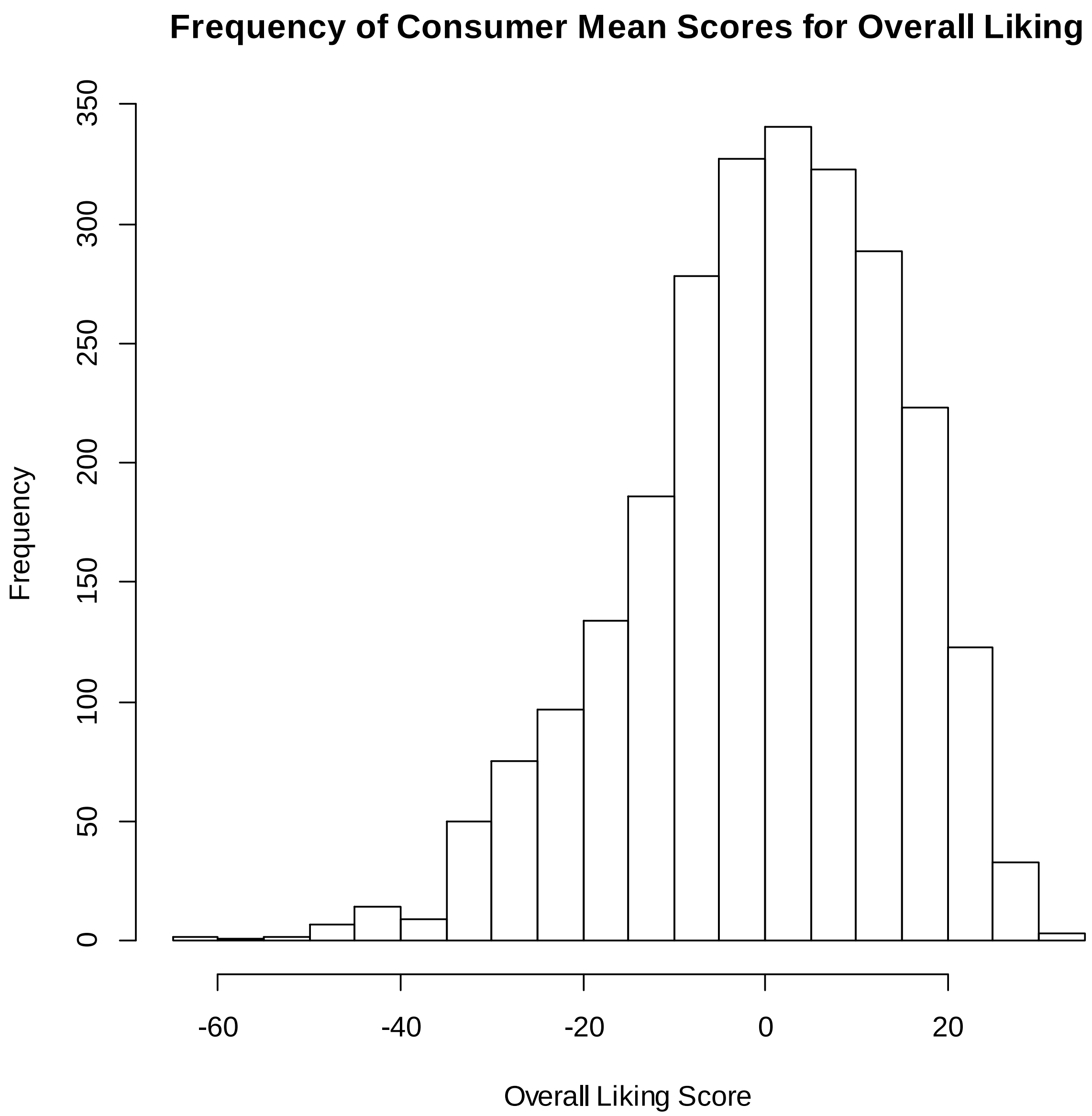


Figure 2.2; A 3D plot of star category against tender and flavour as fitted by a generalised additive model smoother.

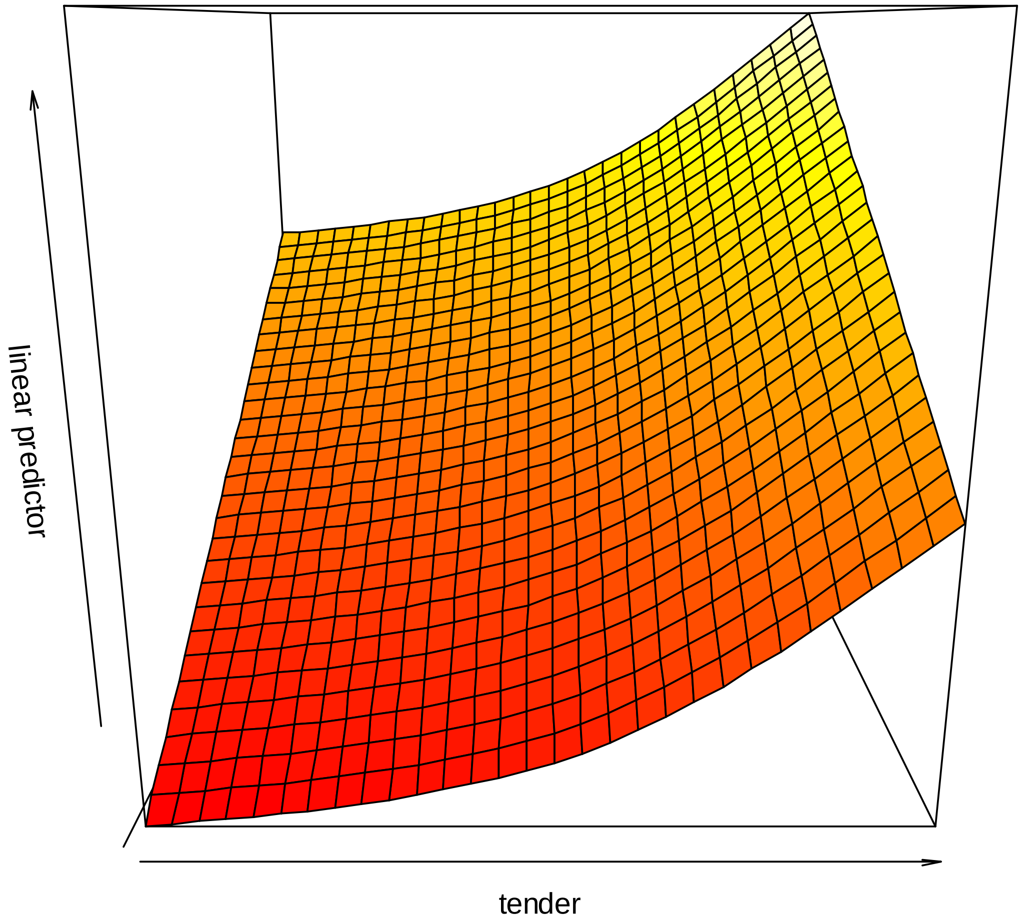
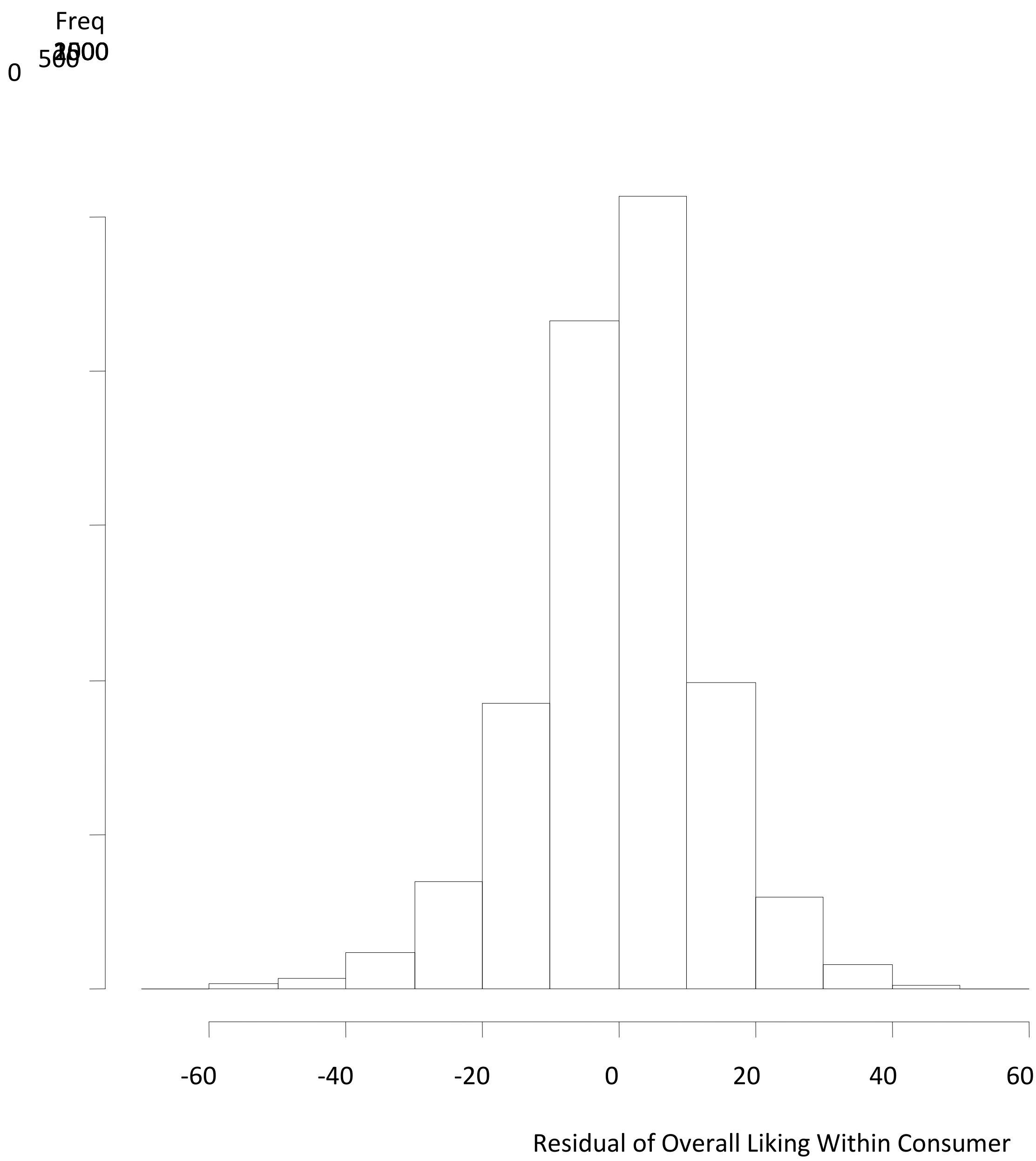


Figure 3: Histogram of the within consumer residuals for Overall Liking.



Milestone 3

Relationship between Overall Liking and Tenderness, Juiciness and Flavour

The sensory variable overall liking is not well defined in the sense of being associated with a particular meat quality trait, especially a measureable trait. Overall liking is correlated to the other sensory variables and might be thought of as including the attributes of these variables plus any aspect of eating quality that was not represented by the other sensory variables. In this respect overall liking is a check on the efficacy of the other sensory variables to capture the key aspects of eating quality to the consumer.

The residuals from overall liking after fitting the other sensory variables, tenderness, juiciness and flavour then measures what eating quality attributes might be lacking in a description of sheep meat eating quality by these 3 variables.

The regression coefficients describing the relationships between overall liking and the sensory variables tenderness, juiciness' and flavour are given in Table 1.3 for both the Loin and Topside cuts. The high adjusted R – squared values for both cuts indicate that most of the eating quality attributed detected by the consumer are captured by the 3 sensory variables tenderness, juiciness and flavour.

The similarity of the regression coefficients between the loin and the topside cuts is notable as are the proportions of variance in overall liking captured by the relationship with the other sensory variables. The residual error for the topside cut is larger than for the loin cut, although this difference is not significant.

The frequency distribution of the residuals from overall liking after fitting the other 3 sensory variables is shown in Figure 1.3. This frequency distribution has significant ($P < 0.001$) positive kurtosis. This means the distribution is peaked, with fat tails, which describes a situation where there are a high proportion of large deviations in this variable. That is, there are a high number of cases where the consumer's evaluation of overall liking includes aspects unrelated to tenderness, juiciness and flavour – at least in the linear (proportional) sense. One must be aware that these high deviations might result from complex nonlinear associations of tenderness, juiciness and flavour detected by the consumer.

When the residuals from overall liking were fitted to the linear mixed model which included the effects of sire breed, kill group, sire within sire breed within kill group and consumer within pick there were no significant effects for any factor. The intra – class correlation coefficient for consumer within pick was 0.14 for the loin cut. This suggests that there were no important attributes of consumer eating quality associated with the factors of interest that were not captured by the 3 sensory variables tenderness, juiciness and flavour.

Linking Sire Variance to Consumer Eating Quality Score

The sire within sire breed within kill group intra – class correlation coefficient for the optimal discriminant function for the loin (reported in milestone 2) was 0.05. This low value was probably the result of the perturbations in consumer judgements referred to in the introduction.

The linear canonical function for the loin cut which maximised the relationship with the sire effect was found to be a contrast between tenderness and juiciness:

$$2.0273(\text{tender}) - 0.6943(\text{juicy})$$

The sensory variable flavour did not improve the canonical correlation with sires for the loin, so was not included. Neither did the residuals of overall liking contribute, suggesting that there were no eating quality attribute associated with a sheep sire effect not already measured by tenderness and juiciness.

This canonical function gave an intra – class correlation for the sire within sire breed within Kill group effect of 0.08 for the loin cut. While still low, this figure was considerably higher than the intra – class correlation of 0.05 calculated for the optimal linear discriminant function reported in Milestone 2.

The topside cut provided a maximal canonical correlation function that was also a contrast between tenderness and juiciness of:

$$3.5(\text{tender}) - 0.25(\text{juicy})$$

Similarly, flavour and overall liking residuals did not add anything to this relationship. However, the high positive correlation of flavour to tenderness and juiciness for both loin and topside cuts would ensure that flavour variation was represented in the relationship with sires.

However, for the topside cut there were a range of coefficients between 2 and 5 for the tender and between 0.1 and 1.0 for the juicy which gave essential the same sire intra – class correlation coefficient of 0.05. This figure was marginally better than the sire intra – class correlation coefficient for the optimal discrimination function for the topside cut of 0.03.

The logit coefficients for the sire based linear canonical function are given in Table 2.3 for the loin cut and Table 3.3 for the topside cut.

The predictability of these new sire based discriminant functions are shown in Table 4.3 for the loin cut and Table 5.3 for the topside cut. The accuracy of the new sire based discriminant function for the loin cut is very similar to that of the optimal discriminant function. Indeed, this sire based discriminant function is better at discriminating between loin cuts of consumer star 4 and 5. However, the accuracy of the new sire based discriminant function for the topside cut is much poorer than that of the optimal discriminant function for this cut.

The residuals calculated after fitting the full model were significantly ($P < 0.01$) skewed and significantly ($P < 0.01$) kurtosis. This was undoubtedly due to the asymmetric nature of the consumer judgements described earlier. Trimming the data set by removing all data points that had absolute residuals greater than 10 resulted in a notable improvement in estimation. The sire intra – class correlation for the optimal discriminant function improved to 0.2 for the loin and 0.16 for the topside. This trimming removed 2265 data points from 7546 data points in the Loin measurements (30%) for the loin and 4325 observations from 7561 observations (57) for the topside cut. Trimming less data points in the set by including those data cases with absolute residuals that were greater than 10 did not improve the sire intra – class correlation much over the complete data case. This result implies that the nature of the frequency distributions for the eating quality variables induced by asymmetric consumer behaviour needs attention.

Fitting statistical models that did not include the sire breed effect or included a non significant maternal effect, or breed type, did not improve the sire intra – class correlation. It was noted in the report for milestone 1 of this project that maternal breed or breed type had no significant effect of the sensory variables.

Seeking a Better Cut - off for Discriminating Consumer Eating Quality Scores

Figures 2.3 to 6.3 show the distributions for each of the eating quality star ratings for the loin cut of the calculated probability from the logit based discriminant function of being classified in the correct consumer rated category. These graphs illustrate the difficulty of seeking cut – off scores that better define the consumer eating quality star ratings in terms of the EQ sensory variables. Ideally one would seek a discontinuity in the probability (frequency) estimates of meat with given sensory variable attributes of being in a given star group. Such a discontinuity is apparent for those EQ star ratings that are far apart (e.g. star 2 v star5), but there is no obvious cut off for any adjacent consumer eating quality scores.

The inclusion of estimates of the economic value of the meat cuts might change this situation. Economic values would define the cost of classification errors, whether incorrectly classifying a meat cut up or down. For example, it might be economic to make it harder to get a meat cut into star 5 because the cost of incorrectly classifying star 4 as star 5 is high.

Nonlinear Relationships

To this stage of the analysis the relationships between variables of interest have been restricted to the linear case. This may be an undue restriction because nonlinear relationships that cannot be approximated linearly will be missed. Nonlinear relationships, between, for example, overall liking and the other sensory variables, can be described by the total correlation. Total correlation refers to a means of, finding unknown functions *f(x)* and *g(y)* that maximise the product moment correlation between these functions of the variables rather than the variables. For example, the task is to find these unknown functions so that the correlation between the functions f*(overall liking)* and *g(tender, juicy, flavour)* is maximised. This is a difficult task since the form of the functions must be derived from the data.

The Alternating Conditional Expectation algorithm was applied to estimate any nonlinear relationships among the sensory variables, and with the sire effect. The relationship between the optimal nonlinear function of overall liking and the optimal nonlinear function of tender, juicy and flavour did not differ significantly from a linear function. However, the optimal nonlinear function relating tender, juicy and flavour to consumer (as a category variable) showed a distinct, though non – significant discontinuity in tenderness and juiciness at the mean of these variables.

Applying this nonlinear relationship with tenderness and juiciness to the mixed linear model did not change the estimates of the intra – class correlations for the sires, but did affect the intra – class correlations for the consumer within pick. For tenderness the consumer within pick intra – class correlation increased from 0.23 for tender measurements less than the mean to 0.41 for tender measurements greater than the mean. For juiciness the corresponding intra – class correlations were 0.29 less than the mean for juiciness and 0.36 for greater than the mean.

Relationship of Sire Best Linear Unbiased Predictions to Carcass Variables Best Linear Unbiased Predictions

It should be noted that the variance components for the sire effects on the sensory variables are relatively low. Thus it should not be expected that the impact of a particular sire on meat eating quality would be high, or even noticeable, when compared with other factors such as the consumer effect. In this respect there is insufficient variation associated with a sire effect to classify sheep meat eating quality on this basis.

Table 6.3 shows the sire BLUPs corrected for deviations due to sire breed for each of the sensory variables and for the linear discriminant function. The sires in Table 6.3 are ranked by the value of the linear discriminant function, showing the preference of consumers for the progeny of particular sires. It is clear that sires of the Merino breed are ranked high and sires of the Poll Dorset breed are ranked low. However, sire ranks are confounded to some extent by the variation in consumer judgement where subclass numbers for particular sires are low as previously noted.

Table 7.3 shows the correlations between the sire BLUPs for the carcass variables and the sire BLUPs for the optimal discriminant function for the sire BLUPs for the sensory variables. There are relatively high correlations between the discriminant function values and intra – muscular fat, shear – force and GR fat tissue, suggesting aspects of a genetic relationship between these carcass variables and sheep meat eating quality.

The best prediction equation relating the optimal discriminant function of the sire BLUP's for tenderness, juiciness, flavour and overall liking and the sire BLUPs for the carcass variables was

$$\text{Discriminant BLUP} = 6.46(\pm 0.0202) - 0.0768(\pm 0.0164)\text{SHEARF5} + 0.0823(\pm 0.0102)\text{HGRFAT}$$

This regression accounted for 45% of the variation in the optimal discriminant function using the sire BLUPs for the sensory variables (tender, juicy, flavour and overall liking) for the star ranked eating quality.

An alternative prediction equation that used the intra – muscular fat measurement instead of the HGRFAT measurement was:

$$\text{Discriminant BLUP} = 6.46(\pm 0.0225) - 0.0553(\pm 0.0132)\text{SHEARF5} + 0.1398(\pm 0.0513)\text{IMF}$$

This equation accounted for 35% of the variation in the optimal discriminant function using the sire BLUPs for the sensory variables (tender, juicy, flavour and overall liking) for the star ranked eating quality. The standard deviation of the regression is 0.1942.

The relationship of the discriminant function with the sire breeding values is given by the regression:

$$\text{Discriminant BLUP} = 3.5005(\pm 0.1147) - 0.1100(\pm 0.0244)\text{PWWT} - 0.3836(\pm 0.1076)\text{PEMD} + 0.5907(\pm 0.1908)\text{PFAT}$$

This regression on the sire breeding values accounted for 55% of the variation in the sire BLUPs of the linear discriminant function.

By relating the sire BLUP estimates for the logit equations defining the probabilities that meat with given sensory variable values to the BLUP values for the carcass variables, the improvement in the probability (frequency) that a given sire would produce meat classified as EQ star 5 was improved by 0.07 for each unit decrease in the shear – force BLUP estimate for the given sire. The improvement in the probability (frequency) that a given sire would produce meat classified as EQ star 4 was improved by 0.004 for each unit decrease in the shear – force BLUP estimate for the given sire, and by 0.011 for each unit increase in the amount of intra – muscular fat.

The regression between the logit calculated probabilities and the shear – force and intra – muscular fat accounted for 40% of the variance in the logit calculated probabilities. Given the prediction accuracy of the discrimination function illustrated in the report for Milestone 2 any association of a particular sire with sheep meat eating quality would be inaccurate. However, the results indicate that a slow improvement in sheep meat eating quality through sire selection might be feasible.

Table 8.3 shows logit calculation for the probabilities that the average progeny from each sire would be classed as consumer star 4. This calculation is consistent with the results from discriminant analysis. It is clear that some sires are more likely to sire progeny with consumer star 4 eating quality, while other sires tend to have progeny more likely to be in consumer star 3. However, the differences are not great, reflecting the strength of other influences on consumer eating quality. The probability that the average progeny from any sire is in star 5 is low.

The practice of clipping the data to remove consumer evaluations that were extreme was tested to see if such a procedure would improve the sire effect on eating quality. Accordingly, those observations with residuals on Overall Liking after fitting the full model greater than an absolute value of 5 units (±5 units) were removed. The sire BLUPs for this amended data set are shown in Table 9.3. A new logit analysis was performed on this amended data set to obtain the coefficients to calculate the probabilities that a meat sample with given sensory variable characteristics would fall into the different eating quality star classifications. These calculations based on the sire BLUPs were as follows:

$$X1 = \exp(-4.9361 + 0.0064\times\text{tender} + 0.0059\times\text{juicy} + 0.0273\times\text{flavour} + 0.0962\times\text{overall})$$

$$X2 = \exp(-13.573 + 0.0265\times\text{tender} + 0.0153\times\text{juicy} + 0.0354\times\text{flavour} + 0.1802\times\text{overall})$$

$$X3 = \exp(-27.079 + 0.0496\times\text{tender} + 0.0344\times\text{juicy} + 0.0572\times\text{flavour} + 0.2696\times\text{overall})$$

$$\text{Star 2} = 1/(1 + X1 + X2 + X3)$$

$$\text{Star 3} = X1 / (1 + X1 + X2 + X3)$$

$$\text{Star 4} = X2 / (1 + X1 + X2 + X3)$$

Star 5 = X3 / (1 + X1 + X2 + X3)

Table 10.3 gives the probabilities calculated from the above procedure that progeny from each sire will be allocated to each of the 4 star eating quality categories after removing those observations in each of the sensory variables that had an absolute deviation greater than 5 units (±5 units). This action provided much more scope in terms of the discrimination of sires for sheep meat eating quality, as may be noted from a comparison of Tables 8.3 and 10.3.

Discussion

The relationship of overall liking to the other sensory variables (tenderness, juiciness and flavour) through the residuals formed after fitting these variables to overall liking shows that there exists substantial variation in eating quality as judged by the consumer not linearly associated with the other 3 sensory variables. The fat tails of the frequency distribution of the overall liking residuals illustrate this issue. In the report for Milestone 2 it was noted that differences in consumer reference points for judging eating quality and the sensory variables were significant, but consistent between sensory variable within consumer. This means that the high residual deviations for overall liking were unlikely to be associated with different consumer reference points and probably captures other aspects of sheep meat eating quality not associated with tenderness, juiciness or flavour.

These large deviations, that might be associated with complex interactions defining eating quality, though not dominant, appear to be sufficiently frequent to confound relationships between consumer judged eating quality and traits in the animal open to genetic improvement.

The lack of any relationships between the residuals of overall liking and the factors of interest, especially sire variation, suggests that those aspects of sheep meat eating quality not linearly associated with the 3 sensory variables (tenderness, juiciness and flavour) are not an issue for these unexplained factors. That is, for the goal of genetic improvement of consumer sheep meat eating quality consideration of the 3 sensory variables tenderness, juiciness and flavour is sufficient.

The optimal discrimination in the sense of providing the best classification for sheep meat eating quality across all 4 consumer star ratings presents an uncomfortable degree of miss – classification at all consumer star ratings. This degree of miss – classification cannot be improved by hierarchical discrimination procedures whereby a second discrimination function is sought for e.g. discriminating meat cuts already classified as star 4 or star 5. This was reported on in Milestone 2. The analysis reported here suggests that miss – classification is due to aspects not captured in the simple models applied here.

This limit in discrimination of consumer eating quality based on the sensory variables, tenderness, juiciness and flavour appears to reside in the variability of consumer judgement of eating quality, where consumers adopt different reference points for their judgement. Although this consumer characteristic confounds the classification of sheep meat eating quality it nevertheless is an important feature of real sheep meat eating consumer behaviour and must be considered. This means that a given (perhaps significant?) proportion of consumers will always judge sheep meat poorly that the majority of consumers consider to be excellent quality. Defining such interactions in a manner required for objective analysis will need research by food scientists. It would seem that there is scope here for research aiming to understand this phenomenon, with the advantage of perhaps being able to define sheep meat with characteristics to suit different palettes

This consumer behaviour also confounds the goal of designing a program for genetic improvement of sheep with better meat eating quality. Varying the cut – off points for star classification through the sensory variables did not confer any advantage, probably because of the poor relationship of consumer star rating to the sensory variables as measured by the intra – class correlation coefficient.

As an alternative to varying the cut – off points of the optimal discriminant function it is suggested that another discriminant function, which is sub – optimal for consumer classification, but optimal for genetic progress in sheep eating quality be adopted. One approach is to use the linear function is based on the canonical correlation between the residuals of the linear model calculated without fitting the sire within sire breed within kill group effect, and the sire effect. Using this construction as a discriminant function considerably increases the intra-class correlation for the sires (enabling better scope for selection for eating quality) without materially decreasing the effectiveness of the classification for consumer eating quality for the loin cut. That is, a sub – optimal discriminant function based on maximising the potential for genetic improvement based on sire selection had similar discrimination accuracy to the optimal case for the loin cut.

However, for the topside cut the best linear function of the sensory variables for maximising the sire intra – class correlation provided very poor predictability in terms of the consumer eating quality. Alternatively, the optimal linear discriminant function for consumer predictability showed lower sire intra – class correlation, and if applied in a breeding program would lead to a lower rate of genetic gain directed to improving the eating quality of this cut. This suggests that measurements of eating quality for genetic selection might be based on the better eating quality cuts like the Loin.

It is notable that adding either flavour and/or the residuals from overall liking to the new linear discriminant function based on maximising the potential for genetic progress in sheep meat eating quality did not improve the situation. This is an advantage since both flavour and overall liking are subjective variables difficult to measure and undoubtedly with considerable consumer variation.

The alternative approach of redefining the population of consumers to include only those consumer judgements that deviate from the population mean by plus or minus 5 units provides a significantly better delineation of between sire differences. If sires were selected using a ranking based on this subpopulation, genetic progress to improve eating quality for this subpopulation might be expected. The important question is how such a strategy relates to the general population of consumers in terms of an increasing the number of animals judged to be in the high eating quality categories.

The idea of using a linear function in the sensory variables to direct selection for consumer sheep meat eating quality that is sub – optimal for predicting/discriminating consumer eating quality needs debate and examination in the science community. There may be other nonlinear functions of the sensory variables that better serve the 2 goals of consumer predictability and efficient genetic selection. Such a formulation might require a better understanding, and correction for, the variability in consumer's perceptions/judgements about the desirability of sheep meat. Undoubtedly, such variation in consumer perceptions contributes to the uncertainties in formulating a sheep meat eating quality improvement program.

An attempt to investigate nonlinear relationships among the variables of interest using ideas from total correlation did not identify useful relationships. However, the increase in the consumer within pick intra – class correlation for those samples rated above average for both tenderness and juiciness points towards an understanding of consumer behaviour in regard to sheep meat eating quality. When tenderness and juiciness were judged to be above average consumers became more consistent in their ratings. However, this did not improve the intra – class correlation with sires, and so while identifying an interesting aspect of consumer behaviour this does not advance the case for improved animal breeding. This observation about the heterogeneity of consumer judgement is consistent with finding a canonical function that had similar discrimination to the optimal for the loin cut, which has a higher eating quality score than the topside, where the canonical function showed very poor discrimination ability.

This analysis and the earlier analyses present a consistent picture of gaps in the scientific understanding of the consumer judgement of sheep meat eating quality. In particular, the variation in consumer reference points (that nevertheless are consistent over both the sensory variables and the EQ classification), with the low (but higher than normal) frequency of deviations in judgement. While of relatively low frequency these deviations are sufficient to confound any links between consumer eating quality and variables that can be directly measured and linked to animal performance. One would hope for the identification of a proxy variable characterising these deviations that can be used as a covariate and better line up the consumer judgement of eating quality with selection of animals for genetic improvement of this trait. This may be a goal for future research.

The marked improvement in the relationship between the consumer eating quality and the linear discriminant function of the eating quality variables induced by drastic trimming of the data suggests that the asymmetry of consumer judgement is a factor of great importance. In essence this response to data trimming is evidence that a better understanding of the frequency distributions underlying consumer judgement is needed. If a suitable frequency distribution describing how consumer judgement varied could be derived, then the analysis should be redone with this basis. Currently the necessary treatment of consumer within pick as a random variable tends to align this variable with a normal distribution – which it clearly is not. I understand there are ways to proceed further, based on ideas of an analysis of skewness, or analysis of kurtosis related to an analysis of variance that might be fruitful. However, pursuing these directions is a major undertaking. The question is whether this is valuable in terms of the insights and better genetic estimates that might result.

An illustration of the difficulties introduced by the consumer variation of subjective judgement of sheep meat eating quality may be given. If the analysis is carried out for overall liking in the loin cut, ignoring the consumer effect (i.e. regarding the consumer variance as part of the error variance) then 2068 observations out of 7473 total observations have a deviation below -10 units – or a deviation of over 10% from the estimated mean. This is a frequency of about 0.3, which is also the probability that an observation will deviate from the consumer average judgement of overall liking. If 10 consumers are randomly selected to judge the meat from a given sire the probability that at least half of those consumers (<=5) will downgrade the meat by more than 10% of the consumer average is 0.1. The probability of at least 3 of the consumers downgrading the meat more than 10% is 0.27. In the first case it would be expected that about 10 of the 97 sires measured would be thus affected. This clearly contributes to the sire variance and reduces the genetic "signal.

This example illustrates the limitations of using the subjective judgments of a heterogeneous group of consumers to rank sires for sheep meat eating quality. However, the consistency of judgments within a consumer noted earlier also suggest that a better basis for analysis might be possible if a good description of the frequency distribution of consumer responses could be found. Suppose for the sake of argument that the observed consistency of consumer response could be used in a simple test to rank consumers. This ranking could be used as a covariate in the analyses to correct for the skewed frequency distribution. It could also be applied to better allocate consumers to samples to ensure a representative sampling of the sire attributes.

Using the sire BLUP estimates as response variables appears to have a similar effect to trimming the data. The sire BLUPs are estimated in the presence of the consumer within pick effect, and while the consumer within pick estimates are treated as a normal distribution by the variance component estimation process it seems to remove a sufficient amount of variability from the eating quality variables to expose sire effects. Thus the variation in the sire BLUP estimates are low as are the variations in the logit estimates of the probabilities of average of the progeny from a sire being in a given eating quality classification. That is, using the sire BLUP estimates as response variables is similar to trimming the data to remove the high proportion of outliers. In this respect this type of analysis better defined in terms of the population of consumers than an arbitrary trimming of the data

However, the relationships between the sire BLUPs for the shear – force and GR tissue depth or intra – muscular fat, and the optimal discriminant function based on the sire BLUPs for the sensory variables (tenderness, juiciness, flavour and overall liking) indicate that selection for tenderness measured by shear – force and GR fat or intra – muscular fat would result in an improvement in sheep meat eating quality. The high amount of variation in the optimal discriminant function accounted for by shear – force and GR fat or intra – muscular fat is encouraging. However, the uncertain reliability of the discriminant function to identify the consumer eating quality classification must be kept in mind.

It is also noted that the sire components of the linear discriminant function are strongly related to the sire breeding values for post weaning weight, post weaning eye muscle area and post weaning fat. It also appears that selection on these attributes would directly improve sheep meat eating quality as defined by the linear discriminant function.

Table 1.3. Regression coefficients for the regression of overall liking on tenderness, juiciness and flavour for the loin and topside cuts

Factor	Loin	Topside
Intercept	1.8300 ± 0.3127	0.2200 ± 0.2803
Tender	0.2059 ± 0.0060	0.2912 ± 0.0062
Juicy	0.1415 ± 0.0057	0.1497 ± 0.0070
flavour	0.6437 ± 0.0057	0.5603 ± 0.0068

Adjusted R^2	0.89	0.86
Residual standard error	6.661	8.670

Table 2.3: Multinomial logit estimates for the star rating depending on the canonical linear function EQ variables for the Loin. The reference is star 2. The canonical function is 2.0273(tender) – 0.6943(juicy)

Star rating	Intercept	Canonical function
3	-0.2771 ± 0.1143	0.0234 ± 0.0014
4	-3.2353 ± 0.1568	0.0524 ± 0.0017
5	-7.0380 ± 0.2288	0.0815 ± 0.0022

Table 3.3: Multinomial logit estimates for the star rating depending on the canonical linear function EQ variables for the Topside. The reference is star 2. The canonical function is 3.5(tender) – 0.25(juicy)

Star rating	Intercept	Canonical function
3	-1.9763 ± 0.0731	0.0019 ± 0.00055
4	-6.7768 ± 0.1656	0.0373 ± 0.00085
5	-14.3260 ± 0.4805	0.0613 ± 0.0018

Table 4.3: The number of samples correctly and incorrectly classified for the loin cut for discrimination using the canonical function, and for comparison, using the optimal linear discriminant function.

(a) Canonical discriminant 2.0273(tender) – 0.6943(juicy)

Star Rating	Estimate 2	Estimate 3	Estimate 4	Estimate 5
Actual 2	264	275	7	0
Actual 3	103	1818	590	75
Actual 4	0	595	1518	501
Actual 5	0	44	524	1232

(b) Optimal discriminant function

Star Rating	Estimate 2	Estimate 3	Estimate 4	Estimate 5
Actual 2	357	187	2	0
Actual 3	172	1743	614	62
Actual 4	1	490	1663	452
Actual 5		30	554	1216

Table 5.3: The number of samples correctly and incorrectly classified for the topside cut for discrimination using the canonical function, and for comparison, using the optimal linear discriminant function

(a) Canonical discriminant 3.5(tender) – 0.25(juicy)

Star Rating	Estimate 2	Estimate 3	Estimate 4	Estimate 5
Actual 2	1643	548	6	0
Actual 3	401	2743	424	44
Actual 4	9	471	561	209
Actual 5	0	32	106	252

(b) Optimal discriminant function

Star Rating	Estimate 2	Estimate 3	Estimate 4	Estimate 5
Actual 2	1053	1015	107	24
Actual 3	720	2467	355	71
Actual 4	128	728	318	77
Actual 5	39	145	126	81

Table 6.3. The sire BLUP estimates corrected for sire breed for each of the sensory variables and the linear discriminant function. Sires are ranked by the value of the linear discriminant function.

sire	breed	tender	juicy	flavour	overall	discriminant
s4800552007070068	Prime Samm	81.6874	73.8689	75.8638	78.1847	6.9452
s5044702006060022	Merino	80.4416	73.4703	74.3812	78.0300	6.9036
s4800872006060421	Prime Samm	79.5447	73.4141	74.6845	77.3054	6.8538
s5030542004040585	Merino	80.6781	71.9123	74.6299	77.1686	6.8462
s5018852006TRIMPH	Merino	78.6125	73.2597	74.5303	76.8304	6.8129
s5039462007OLY716	Merino	78.0420	71.0759	74.3492	76.9376	6.7978
s5024252006023997	Merino	78.7943	73.1159	74.1812	76.5287	6.7911
s4800992006060191	Prime Samm	77.7195	71.9678	74.3777	76.7721	6.7906
s4800392007070062	Prime Samm	79.1436	71.0529	74.3969	76.4915	6.7816
s6013322004000WD2	Poll Merino	79.7555	72.8214	73.5047	76.2359	6.7727
s5047432000000503	Merino	77.8163	72.2643	73.8497	76.4368	6.7667
s5007882007071254	Merino	77.8898	71.2580	74.0744	76.3918	6.7608
s5000872006060096	Merino	78.6136	71.6924	73.9411	76.2430	6.7600
s5039822006060225	Merino	78.2670	71.5858	73.8424	76.2617	6.7559
s0219292007070261	Border Leicester	75.9971	72.4083	73.7303	76.1198	6.7291
s6008152006060120	Poll Merino	78.3358	71.4661	73.1890	75.8345	6.7219
s5034252006060205	Merino	76.8297	71.6614	73.7280	75.9237	6.7204
s5022512006066030	Merino	78.1147	70.3940	73.8178	75.5249	6.7014
s5030972005051737	Merino	78.4572	70.7765	73.6985	75.4088	6.6987
s5038632006OL3626	Merino	77.9833	71.6868	72.8515	75.5321	6.6974
s2301132007070040	White Suffolk	77.5246	72.3013	73.5920	75.2693	6.6896
s6013562007000449	Poll Merino	78.4187	69.8001	73.2099	75.1344	6.6695
s6010532003031078	Poll Merino	76.8150	70.5864	73.4278	75.1783	6.6642
s5043622006LON449	Merino	77.2181	71.6193	73.0439	75.0575	6.6628
s020041200707J039	Border Leicester	76.8833	69.7179	73.0544	75.2714	6.6606
s6005712006060058	Poll Merino	75.4041	70.5225	73.4544	75.2520	6.6549
s5037892007LB0753	Merino	77.6711	70.0862	73.3047	74.8798	6.6496
s1900282007071494	Suffolk	76.1507	70.6496	72.8738	75.1365	6.6491
s6010822007071257	Poll Merino	76.9666	70.0588	73.3208	74.9164	6.6450
s2303182008080262	White Suffolk	79.2185	72.4153	73.3820	74.1620	6.6365
s5101402006060368	Dohne Merino	76.7714	70.8743	73.2302	74.6370	6.6302
s6013162007070023	Poll Merino	76.1816	70.5774	72.9287	74.7248	6.6244
s2303242007075630	White Suffolk	78.9198	71.6220	73.5713	73.8703	6.6129
s5049022005005345	Merino	75.4816	70.3941	72.6650	74.5857	6.6048
s5046152004040024	Merino	74.2678	69.6803	72.7281	74.7518	6.5994
s6090542006066533	Poll Merino	73.7998	69.6864	73.0919	74.2576	6.5689
s2304502007071456	White Suffolk	77.9406	71.4973	72.7408	73.4403	6.5665
s6005532007070002	Poll Merino	74.1325	70.6319	73.4656	73.8903	6.5601
s5015522006060480	Merino	75.8916	70.6874	71.8019	73.8606	6.5561
s2300432007070591	White Suffolk	74.4733	67.5445	72.4522	74.2735	6.5551
s1700802007071532	Texel	75.9034	69.7116	72.3808	73.7200	6.5482

s1500292007070244	Coopworth	75.2421	68.8232	72.3835	73.7685	6.5391
s1640732007070364	Poll Dorset	75.3105	68.6910	72.3535	73.6111	6.5289
s6004082007070069	Poll Merino	74.5080	69.7294	72.5243	73.5625	6.5268
s1700622007070144	Texel	74.7972	68.1333	72.1289	73.7436	6.5258
s1704062007070028	Texel	76.1031	68.4190	72.0108	73.5173	6.5251
s1702232007070046	Texel	75.9154	68.6201	71.9673	73.5173	6.5240
s5100492007071700	Dohne Merino	77.7820	67.6927	71.3758	73.3842	6.5211
s5000482007070260	Merino	75.2370	69.1489	71.5844	73.5563	6.5187
s6013072005050165	Poll Merino	75.7806	70.3469	72.2985	73.1525	6.5153
s1918502001010120	Suffolk	76.0294	68.1404	72.0373	73.3313	6.5115
s6012882006063091	Poll Merino	74.3527	70.0889	71.3525	73.1095	6.4861
s1619722006061831	Poll Dorset	73.0672	68.8067	72.3357	73.2488	6.4855
s2300262007072446	White Suffolk	74.5173	67.8943	71.9465	73.0662	6.4780
s0300362005050134	Corriedale	76.0885	68.9674	70.8141	72.8771	6.4751
s6011272007070121	Poll Merino	74.6547	67.6129	72.0601	72.9405	6.4711
s50923420060C0573	Merino	75.6504	68.6283	71.0079	72.8585	6.4699
s0246862007070179	Border Leicester	75.1851	67.8465	71.1128	72.9372	6.4664
s6013652006060052	Poll Merino	75.5212	69.1754	70.7879	72.7987	6.4659
s5049162007070719	Merino	75.2921	68.2407	70.9347	72.8119	6.4602
s6012502004407812	Poll Merino	74.4214	68.4012	71.4997	72.7574	6.4561
s4800302008080078	Prime Samm	75.5045	69.1178	72.3733	72.2837	6.4525
s5100302005050068	Dohne Merino	77.1512	68.1197	70.3028	72.4894	6.4503
s0244112006060369	Border Leicester	75.1189	68.6529	70.5956	72.1407	6.4161
s1920452007070508	Suffolk	73.7425	66.7471	71.2230	72.4106	6.4144
s5100092007070376	Dohne Merino	76.2575	69.1057	70.5247	71.8086	6.4089
s2300022007070098	White Suffolk	74.5405	68.0189	70.4244	72.1580	6.4054
s6091542004040062	Poll Merino	71.8070	68.5427	71.3146	71.6945	6.3644
s0236662006060976	Border Leicester	73.5317	67.4777	70.3408	71.6992	6.3631
s5100032007070949	Dohne Merino	73.6441	66.3451	70.0083	71.6542	6.3503
s1900602007070267	Suffolk	73.3218	67.3170	70.4333	71.4372	6.3451
s2300912007070008	White Suffolk	73.3495	65.4125	70.5104	71.3591	6.3293
s2300342007074914	White Suffolk	71.4409	66.3395	70.3128	71.1943	6.3043
s1901112007077058	Suffolk	72.3936	65.6325	70.1320	71.0873	6.3004
s0300182004045220	Corriedale	72.2523	67.0921	69.4421	70.9142	6.2896
s2300152007070143	White Suffolk	72.0411	65.9115	70.0632	70.8230	6.2817
s2300262005050650	White Suffolk	70.9092	64.9590	70.2523	70.6920	6.2589
s1600012008080010	Poll Dorset	72.4168	66.2561	69.3029	70.4986	6.2588
s1622882007070644	Poll Dorset	73.2744	65.8251	68.8061	70.4703	6.2567
s1601852007070369	Poll Dorset	72.1611	65.5258	69.5288	70.3884	6.2475
s2300092007070279	White Suffolk	71.2954	65.1961	69.8944	70.0632	6.2214
s1612352007072025	Poll Dorset	72.0705	65.0185	68.6351	69.9453	6.2057
s1637212007070311	Poll Dorset	70.3045	64.1739	68.8794	69.7338	6.1732
s1636772007070839	Poll Dorset	71.6430	64.1926	68.3250	69.1200	6.1421
s0315272003030360	Corriedale	70.7714	62.9697	68.3403	69.1037	6.1251
s1500622006060070	Coopworth	71.2167	63.7440	68.1312	68.7313	6.1091
s1704202007070224	Texel	69.4352	64.3322	68.6355	68.7601	6.1033

s1618922006060050	Poll Dorset	70.7280	63.5711	67.4405	68.1315	6.0584
s1614152007070440	Poll Dorset	67.5464	62.7924	67.3571	68.1943	6.0254
s1500152003030196	Coopworth	68.3800	63.3124	67.6813	67.6601	6.0079
s0600032006060121	Bond	67.6909	61.4865	67.6141	67.8373	5.9996
s1623682007070468	Poll Dorset	67.4706	62.0475	67.2143	67.4568	5.9731
s0318972006060386	Corriedale	67.7292	62.4851	66.8655	66.6791	5.9267
s1611432007070025	Poll Dorset	65.7779	60.6112	66.2798	66.4258	5.8733
s1500392006061009	Coopworth	68.5912	61.0981	66.2754	65.9178	5.8726
s1500482007070769	Coopworth	66.3231	61.2564	66.6072	65.9069	5.8548
s1611582007070190	Poll Dorset	62.6277	60.1690	65.4870	64.8155	5.7320

Table 7.3. Correlations between the sire BLUP values for the optimal discriminant function and the BLUP values for the carcass measurements of the loin cut.

	IMF	CEMA	LLFAT	HGRFAT	SHEARF5
Optimal linear Discriminant	0.49	-0.32	-0.04	-0.40	-0.53
IMF		-0.31	-0.05	-0.40	-0.53
CEMA			0.08	0.08	0.56
LLFAT				0.28	0.0
HGRFAT					0.05
SHEARF5					

Table 8.3. Calculation from the logit analysis of the probability that progeny from a given sire would be classified by consumers as star 4.

sire	Breed	Probability in star 4
s5046152004040024	Merino	0.55
s5039822006060225	Merino	0.55
s5007882007071254	Merino	0.55
s4800552007070068	Prime Samm	0.54
s4800992006060191	Prime Samm	0.54
s5034252006060205	Merino	0.54
s5030972005051737	Merino	0.54
s5024252006023997	Merino	0.54
s5000872006060096	Merino	0.54
s4800872006060421	Prime Samm	0.54
s5038632006OL3626	Merino	0.54
s4800392007070062	Prime Samm	0.54
s5049022005005345	Merino	0.54
s5044702006060022	Merino	0.54
s020041200707J040	Border Leicester	0.54
s5049162007070719	Merino	0.54
s6010532003031078	Poll Merino	0.54
s5047432000000503	Merino	0.54
s5037892007LB0753	Merino	0.54

s5018852006TRIMPH	Merino	0.54
s6008152006060120	Poll Merino	0.53
s6013652006060052	Poll Merino	0.53
s6004082007070069	Poll Merino	0.53
s020041200707J039	Border Leicester	0.53
s6091542004040062	Poll Merino	0.53
s6011272007070121	Poll Merino	0.53
s5030542004040585	Merino	0.53
s5101402006060368	Dohne Merino	0.53
s6012502004407812	Poll Merino	0.53
s6013322004000WD2	Poll Merino	0.53
s50923420060C0573	Merino	0.53
s6010822007071257	Poll Merino	0.53
s1500292007070244	Coopworth	0.53
s5100032007070949	Dohne Merino	0.53
s2300432007070591	White Suffolk	0.53
s6005532007070002	Poll Merino	0.53
s6005712006060058	Poll Merino	0.53
s6013162007070023	Poll Merino	0.53
s6013562007000449	Poll Merino	0.52
s1900282007071494	Suffolk	0.52
s1619722006061831	Poll Dorset	0.52
s6013072005050165	Poll Merino	0.52
s2300262007072446	White Suffolk	0.52
s6090542006066533	Poll Merino	0.52
s1918502001010120	Suffolk	0.52
s5100302005050068	Dohne Merino	0.52
s5100492007071700	Dohne Merino	0.52
s5039462007OLY716	Merino	0.52
s2300912007070008	White Suffolk	0.52
s5100092007070376	Dohne Merino	0.52
s2300022007070098	White Suffolk	0.52
s1700622007070144	Texel	0.52
s1900602007070267	Suffolk	0.52
s1702232007070046	Texel	0.52
s1704062007070028	Texel	0.52
s1901112007077058	Suffolk	0.52
s1700802007071532	Texel	0.52
s1640732007070364	Poll Dorset	0.51
s5000482007070260	Merino	0.51
s0300362005050134	Corriedale	0.51
s2300342007074914	White Suffolk	0.51
s1920452007070508	Suffolk	0.51
s6012882006063091	Poll Merino	0.51
s2300092007070279	White Suffolk	0.51
s2300262005050650	White Suffolk	0.51
s0246862007070179	Border Leicester	0.51
s2300152007070143	White Suffolk	0.51
s0244112006060369	Border Leicester	0.51
s0219292007070261	Border Leicester	0.51
s0300182004045220	Corriedale	0.51
s1622882007070644	Poll Dorset	0.51
s1637212007070311	Poll Dorset	0.50

s2301132007070040	White Suffolk	0.50
s1636772007070839	Poll Dorset	0.50
s1704202007070224	Texel	0.50
s1601852007070369	Poll Dorset	0.50
s1618922006060050	Poll Dorset	0.50
s2304502007071456	White Suffolk	0.50
s1623682007070468	Poll Dorset	0.50
s2303242007075630	White Suffolk	0.49
s2303182008080262	White Suffolk	0.49
s1600012008080010	Poll Dorset	0.49
s4800302008080078	Prime Samm	0.49
s0315272003030360	Corriedale	0.49
s1612352007072025	Poll Dorset	0.49
s0600032006060121	Bond	0.49
s1500622006060070	Coopworth	0.48
s0318972006060386	Corriedale	0.48
s1614152007070440	Poll Dorset	0.48
s1500152003030196	Coopworth	0.48
s1500482007070769	Coopworth	0.48
s1611432007070025	Poll Dorset	0.48
s1500392006061009	Coopworth	0.48
s1611582007070190	Poll Dorset	0.47

Table 9.3. Sire BLUP values for the sensory variables when the residuals for overall liking with absolute value greater than 5 units are removed.

Sire	Breed	Tender	Juicy	Flavour	Overall
s5044702006060022	Merino	82.3194	75.7913	77.2534	81.7479
s5039462007OLY716	Merino	80.3197	73.1791	78.0831	81.6471
s5030542004040585	Merino	83.364	74.6926	78.1646	80.7959
s4800552007070068	Prime Samm	81.8634	75.4814	78.6298	80.4648
s6008152006060120	Poll Merino	82.6701	75.3481	76.6491	80.3869
s0219292007070261	Border Leicester	79.4651	75.2332	79.6259	81.2147
s5038632006OL3626	Merino	80.1539	75.561	77.9199	80.5206
s4800872006060421	Prime Samm	79.9747	75.2678	77.8155	80.785
s2301132007070040	White Suffolk	79.515	75.4298	77.2825	80.2369
s5039822006060225	Merino	81.0967	73.7433	77.114	80.074
s6013322004000WD2	Poll Merino	82.2346	74.1645	76.9885	79.6606
s4800992006060191	Prime Samm	81.6022	74.1345	76.8089	79.7574
s5018852006TRIMPH	Merino	80.6303	75.4637	77.0301	79.5957
s5024252006023997	Merino	81.7914	74.8008	77.2325	79.6318
s2304502007071456	White Suffolk	80.2646	74.7959	78.4704	79.1483
s5047432000000503	Merino	81.2973	74.1148	76.6557	79.5809
s5007882007071254	Merino	82.3625	74.7304	77.2635	79.2566
s5000872006060096	Merino	81.439	73.8536	76.9756	79.1526
s6010822007071257	Poll Merino	80.6433	73.7457	77.4648	79.2785
s6013162007070023	Poll Merino	80.6246	73.4172	76.6911	79.1119
s4800392007070062	Prime Samm	80.8561	73.0821	76.8838	78.9172
s5034252006060205	Merino	78.7183	73.8192	76.5647	79.2031

s5037892007LB0753	Merino	81.4468	73.7103	76.7029	78.5961
s2303242007075630	White Suffolk	80.2114	74.4726	78.1277	78.5272
s2303182008080262	White Suffolk	80.6549	74.095	77.4738	78.4838
s6010532003031078	Poll Merino	80.3026	73.444	77.2265	78.6824
s5030972005051737	Merino	82.2471	73.6592	76.7596	78.388
s6005712006060058	Poll Merino	78.8185	72.9842	76.8222	79.1869
s6013562007000449	Poll Merino	80.9109	71.417	77.3646	78.8324
s5043622006LON449	Merino	81.1113	74.5859	76.0479	78.2561
s5000482007070260	Merino	78.8935	73.0741	76.9179	78.5753
s5101402006060368	Dohne Merino	79.8374	73.5284	77.1555	78.1795
s6005532007070002	Poll Merino	79.0505	73.572	77.2166	78.6126
s5049022005005345	Merino	79.6855	73.7371	76.2271	78.4025
s4800302008080078	Prime Samm	80.0471	73.6213	77.0791	78.0277
s6013652006060052	Poll Merino	79.6832	72.9803	75.4997	78.0571
s1900282007071494	Suffolk	78.0118	72.6877	75.5244	77.8945
s6090542006066533	Poll Merino	77.7783	72.7714	76.4992	77.9953
s5015522006060480	Merino	78.2427	73.4875	75.9627	78.1118
s1700622007070144	Texel	77.3756	70.2754	75.8723	77.9084
s1700802007071532	Texel	78.4363	72.2702	76.0088	77.4201
s1704062007070028	Texel	78.1815	71.2874	75.4691	77.5163
s6012502004407812	Poll Merino	78.4476	71.9358	76.5492	77.6021
s1702232007070046	Texel	78.7008	71.7015	75.2399	77.3827
s1918502001010120	Suffolk	79.1061	70.8246	75.0394	77.2376
s5100302005050068	Dohne Merino	79.6693	71.0171	74.6099	77.2873
s1640732007070364	Poll Dorset	78.0986	71.4581	75.6265	77.2156
s50923420060C0573	Merino	79.4815	71.4217	74.6109	76.6847
s5022512006066030	Merino	81.2315	72.8401	75.7512	76.816
s2300432007070591	White Suffolk	77.1173	70.3786	74.9214	77.4318
s5100092007070376	Dohne Merino	78.6386	72.0456	76.2007	76.6969
s5100492007071700	Dohne Merino	79.8414	70.2809	74.6344	76.4431
s5049162007070719	Merino	78.2953	71.2538	74.3237	76.3733
s0300362005050134	Corriedale	78.4921	71.4609	74.0238	76.4452
s020041200707J039	Border Leicester	77.0919	71.3067	74.8832	76.6024
s1500292007070244	Coopworth	77.6637	71.8537	74.8874	76.5012
s6004082007070069	Poll Merino	78.7205	72.8572	75.4319	76.3566
s6091542004040062	Poll Merino	76.7442	73.4376	75.4461	76.3902
s0246862007070179	Border Leicester	77.1293	69.5392	74.9835	76.5731
s2300262007072446	White Suffolk	76.6025	69.7516	74.5521	76.6443
s6012882006063091	Poll Merino	78.3234	73.9361	74.6556	76.2495
s6011272007070121	Poll Merino	77.4528	71.1157	75.8714	76.869
s1619722006061831	Poll Dorset	76.3069	71.4805	75.1814	75.7639
s2300022007070098	White Suffolk	77.2608	70.0568	72.8836	75.6701
s0244112006060369	Border Leicester	76.1868	70.0464	73.9755	75.8671
s6013072005050165	Poll Merino	77.8579	72.1153	74.4034	75.4275
s1920452007070508	Suffolk	76.8631	68.7259	73.4282	75.5136
s0236662006060976	Border Leicester	75.5777	70.4175	74.0439	75.3677
s2300912007070008	White Suffolk	76.4218	68.3787	73.6895	75.2468
s5046152004040024	Merino	76.27	72.0367	75.3912	75.4388
s1622882007070644	Poll Dorset	75.3732	68.2876	72.7774	75.157

s0300182004045220	Corriedale	75.0641	70.3037	73.47	75.1901
s1600012008080010	Poll Dorset	75.0669	68.685	72.6735	74.6245
s1900602007070267	Suffolk	76.0982	69.3877	73.0774	74.654
s5100032007070949	Dohne Merino	77.2317	69.7871	72.511	74.9244
s1901112007077058	Suffolk	75.6344	68.5239	72.8558	74.7221
s2300342007074914	White Suffolk	73.6988	69.041	73.1715	73.9558
s1637212007070311	Poll Dorset	73.2813	67.3	72.5173	74.0513
s2300152007070143	White Suffolk	75.0991	68.1914	72.4575	73.7702
s2300262005050650	White Suffolk	73.8332	67.4718	73.0671	74.0026
s2300092007070279	White Suffolk	75.5084	68.1467	72.3593	73.3162
s1612352007072025	Poll Dorset	74.2177	66.103	71.5813	73.31
s1636772007070839	Poll Dorset	74.8372	67.3651	71.5416	73.1841
s1601852007070369	Poll Dorset	73.6574	66.3025	71.8244	73.2055
s0315272003030360	Corriedale	73.7166	65.9239	71.7624	73.2583
s1500622006060070	Coopworth	73.692	65.4439	71.0385	72.4569
s1704202007070224	Texel	72.5561	67.9624	71.8647	72.4565
s1618922006060050	Poll Dorset	73.6258	67.3522	71.1081	72.404
s1614152007070440	Poll Dorset	70.5974	65.4587	70.0981	72.1831
s1623682007070468	Poll Dorset	71.3446	65.1583	70.9652	71.644
s1500152003030196	Coopworth	71.6718	65.6803	70.3335	70.8593
s0600032006060121	Bond	70.9829	64.662	70.4685	71.0917
s0318972006060386	Corriedale	70.1265	65.0725	69.436	69.8194
s1500482007070769	Coopworth	69.9924	63.9331	69.9915	69.8832
s1500392006061009	Coopworth	70.8016	63.9899	69.4282	69.2896
s1611432007070025	Poll Dorset	68.3599	62.6423	68.5607	69.7039
s1611582007070190	Poll Dorset	65.8905	63.7462	68.4155	67.6206

Table 10.3. Probabilities of eating quality classification based on sire BLUP values for the optimal discriminant function when data from each sensory variable is clipped to remove all observations with residuals greater than absolute value 5. Probabilities may be interpreted as frequency of progeny in each star classification.

Sire	Breed	Prob Star 2	Prob Star 3	Prob Star 4	Prob Star 5
s5044702006060022	Merino	0	0.19	0.61	0.19
s5039462007OLY716	Merino	0	0.2	0.61	0.18
s5030542004040585	Merino	0	0.2	0.61	0.18
s4800552007070068	Prime Samm	0	0.21	0.62	0.17
s6008152006060120	Poll Merino	0	0.22	0.62	0.17
s0219292007070261	Border Leicester	0	0.2	0.61	0.18
s5038632006OL3626	Merino	0	0.22	0.62	0.17
s4800872006060421	Prime Samm	0	0.21	0.62	0.17
s2301132007070040	White Suffolk	0	0.23	0.62	0.16
s5039822006060225	Merino	0	0.23	0.61	0.15
s6013322004000WD2	Poll Merino	0	0.23	0.61	0.15
s4800992006060191	Prime Samm	0	0.23	0.61	0.15
s5018852006TRIMPH	Merino	0	0.24	0.61	0.15
s5024252006023997	Merino	0	0.23	0.61	0.15

s2304502007071456	White Suffolk	0	0.24	0.61	0.14
s5047432000000503	Merino	0	0.24	0.61	0.15
s5007882007071254	Merino	0	0.24	0.61	0.15
s5000872006060096	Merino	0	0.24	0.61	0.14
s6010822007071257	Poll Merino	0	0.24	0.61	0.14
s6013162007070023	Poll Merino	0	0.25	0.61	0.14
s4800392007070062	Prime Samm	0	0.25	0.61	0.13
s5034252006060205	Merino	0	0.25	0.61	0.13
s5037892007LB0753	Merino	0	0.26	0.61	0.13
s2303242007075630	White Suffolk	0	0.26	0.61	0.13
s2303182008080262	White Suffolk	0	0.26	0.61	0.13
s6010532003031078	Poll Merino	0	0.26	0.61	0.13
s5030972005051737	Merino	0	0.26	0.61	0.13
s6005712006060058	Poll Merino	0	0.26	0.61	0.13
s6013562007000449	Poll Merino	0	0.26	0.61	0.13
s5043622006LON449	Merino	0	0.26	0.61	0.13
s5000482007070260	Merino	0	0.27	0.61	0.12
s5101402006060368	Dohne Merino	0	0.27	0.61	0.12
s6005532007070002	Poll Merino	0	0.26	0.61	0.13
s5049022005005345	Merino	0	0.27	0.61	0.12
s4800302008080078	Prime Samm	0	0.27	0.61	0.12
s6013652006060052	Poll Merino	0	0.28	0.61	0.12
s1900282007071494	Suffolk	0	0.29	0.6	0.11
s6090542006066533	Poll Merino	0	0.28	0.6	0.11
s5015522006060480	Merino	0	0.28	0.6	0.11
s1700622007070144	Texel	0	0.3	0.6	0.1
s1700802007071532	Texel	0	0.3	0.6	0.1
s1704062007070028	Texel	0	0.3	0.6	0.1
s6012502004407812	Poll Merino	0	0.29	0.6	0.11
s1702232007070046	Texel	0	0.3	0.6	0.1
s1918502001010120	Suffolk	0	0.3	0.6	0.1
s5100302005050068	Dohne Merino	0	0.3	0.6	0.1
s1640732007070364	Poll Dorset	0	0.3	0.6	0.1
s50923420060C0573	Merino	0	0.31	0.59	0.09
s5022512006066030	Merino	0	0.3	0.6	0.1
s2300432007070591	White Suffolk	0	0.31	0.59	0.1
s5100092007070376	Dohne Merino	0	0.31	0.59	0.1
s5100492007071700	Dohne Merino	0	0.32	0.59	0.09
s5049162007070719	Merino	0	0.32	0.59	0.09
s0300362005050134	Corriedale	0	0.32	0.59	0.09
s020041200707J039	Border Leicester	0	0.32	0.59	0.09
s1500292007070244	Coopworth	0	0.32	0.59	0.09
s6004082007070069	Poll Merino	0	0.32	0.59	0.09
s6091542004040062	Poll Merino	0	0.32	0.59	0.09
s0246862007070179	Border Leicester	0	0.33	0.58	0.09
s2300262007072446	White Suffolk	0	0.33	0.58	0.08
s6012882006063091	Poll Merino	0	0.32	0.59	0.09
s6011272007070121	Poll Merino	0	0.31	0.59	0.09
s1619722006061831	Poll Dorset	0	0.34	0.58	0.08
s2300022007070098	White Suffolk	0	0.35	0.57	0.07
s0244112006060369	Border Leicester	0	0.35	0.57	0.08
s6013072005050165	Poll Merino	0	0.34	0.58	0.08
s1920452007070508	Suffolk	0	0.36	0.57	0.07

s0236662006060976	Border Leicester	0	0.36	0.57	0.07
s2300912007070008	White Suffolk	0	0.37	0.56	0.07
s5046152004040024	Merino	0	0.35	0.57	0.08
s1622882007070644	Poll Dorset	0	0.37	0.56	0.06
s0300182004045220	Corriedale	0	0.37	0.56	0.07
s1600012008080010	Poll Dorset	0	0.39	0.55	0.06
s1900602007070267	Suffolk	0	0.38	0.56	0.06
s5100032007070949	Dohne Merino	0	0.37	0.56	0.07
s1901112007077058	Suffolk	0	0.38	0.55	0.06
s2300342007074914	White Suffolk	0	0.4	0.54	0.05
s1637212007070311	Poll Dorset	0	0.41	0.54	0.05
s2300152007070143	White Suffolk	0	0.41	0.54	0.05
s2300262005050650	White Suffolk	0	0.41	0.54	0.05
s2300092007070279	White Suffolk	0	0.41	0.53	0.05
s1612352007072025	Poll Dorset	0	0.43	0.52	0.05

Figure 1.3. Histogram of the residuals of overall liking from the topside cut after fitting the other sensory variables tenderness, juiciness and flavour.

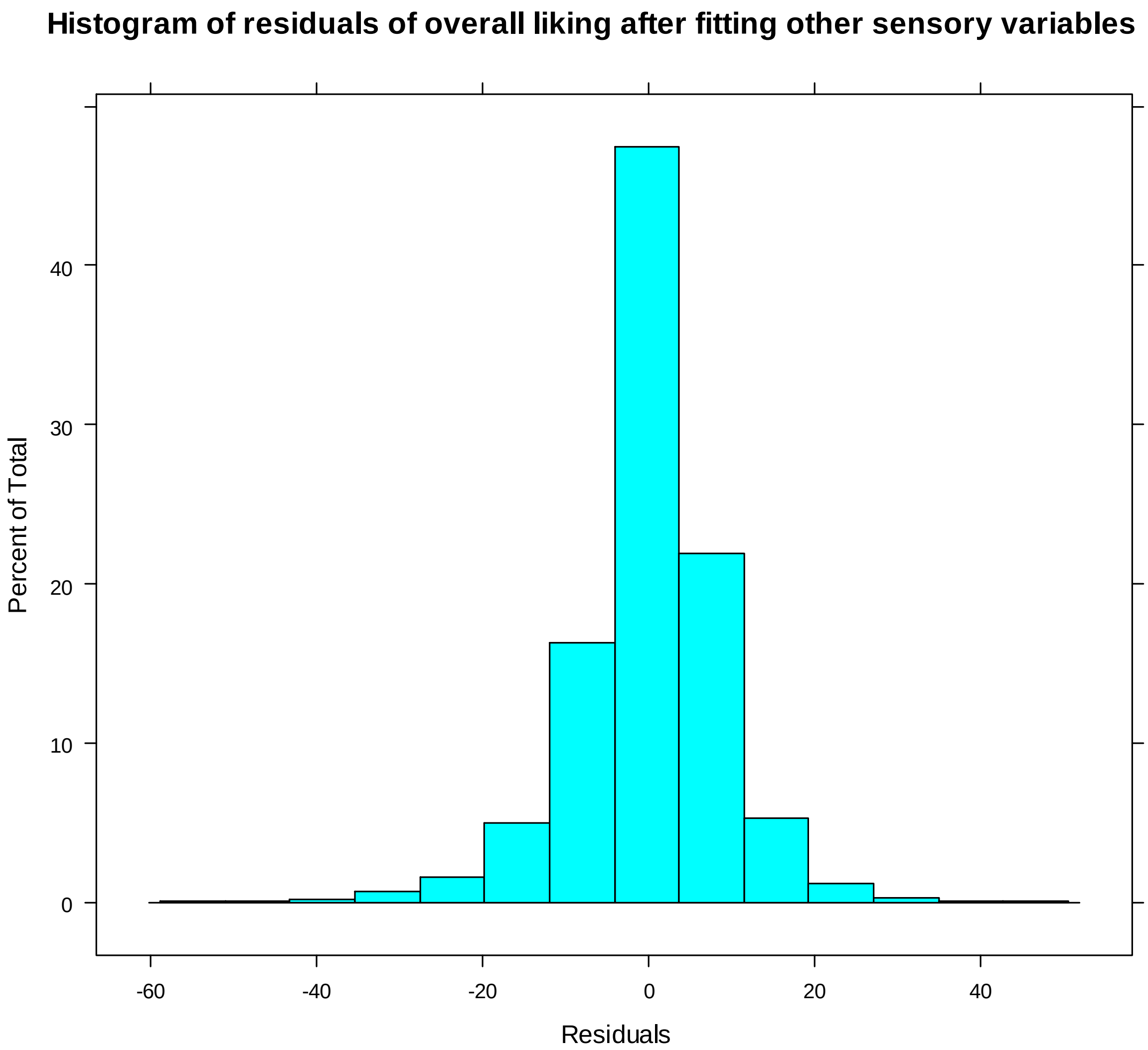


Figure 2.3. Histograms for sheep meat with Consumer Star rating 5 (excellent) and the frequency of classification into each consumer star grade by the optimal discriminant function for the loin cut

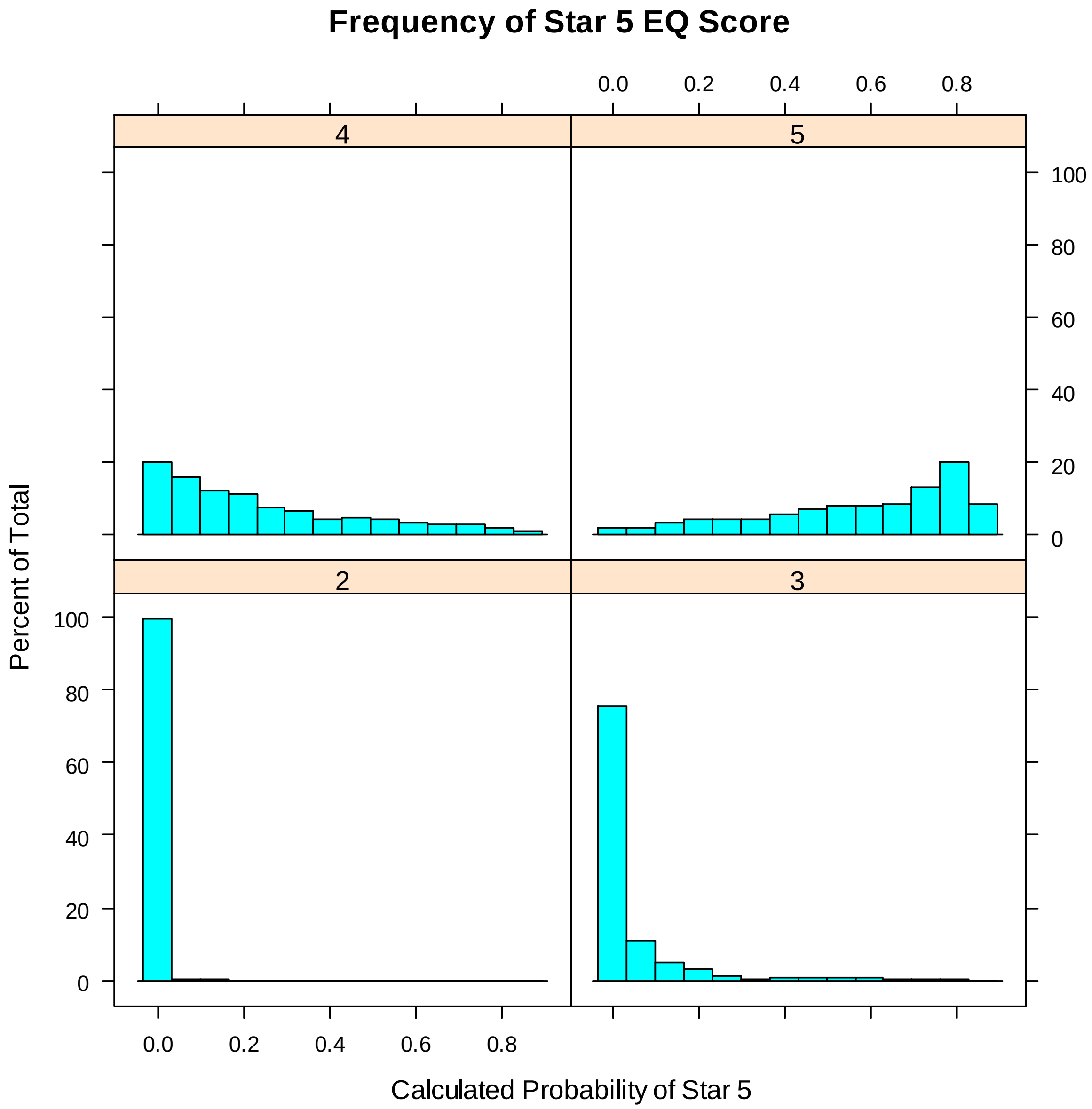


Figure 4.3. Histograms for sheep meat with Consumer Star rating 4 and the frequency of classification by the optimal discriminant function for the loin cut

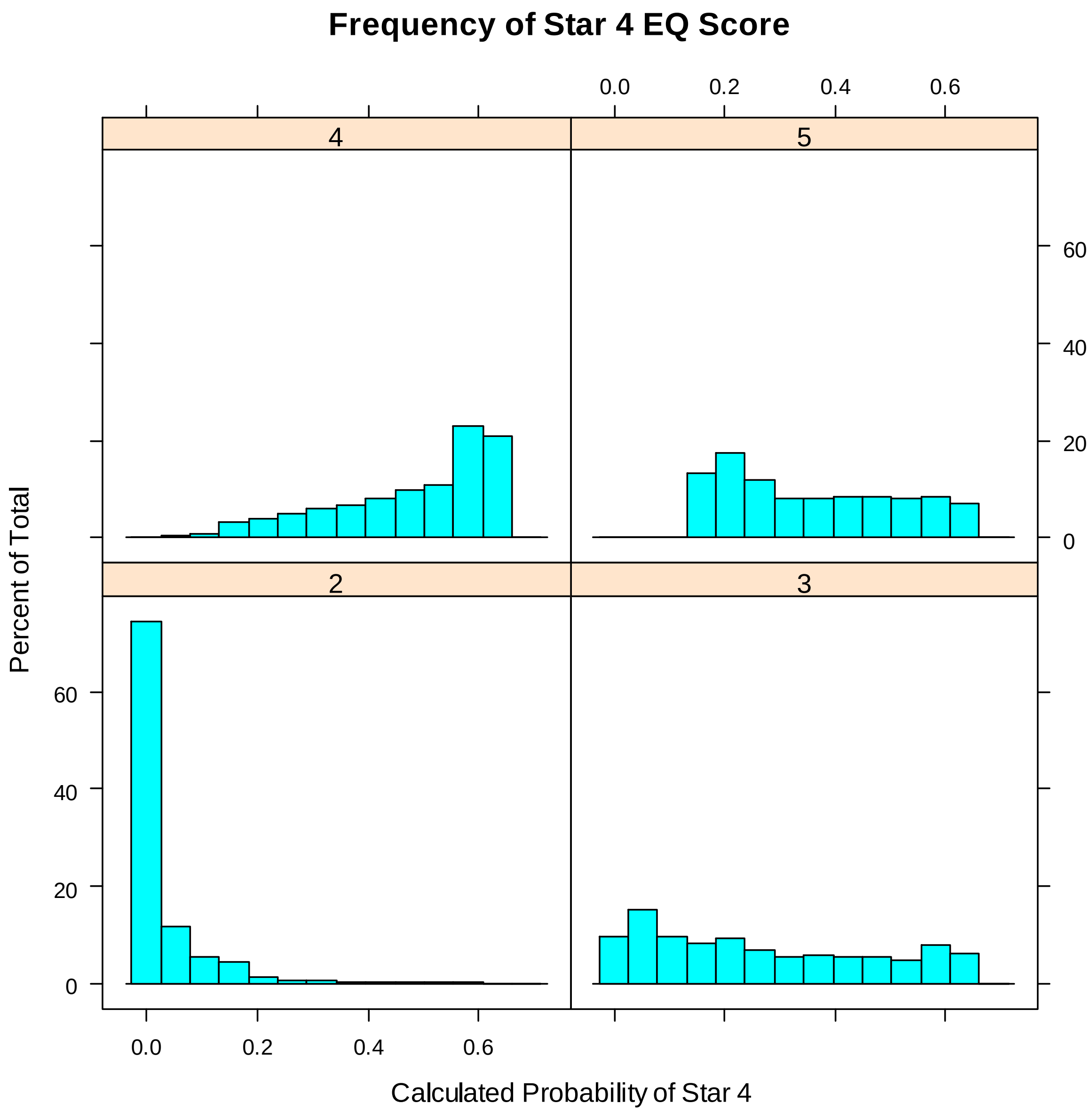


Figure 5.3. Histograms for sheep meat with Consumer Star rating 3 and the frequency of classification by the optimal discriminant function for the loin cut

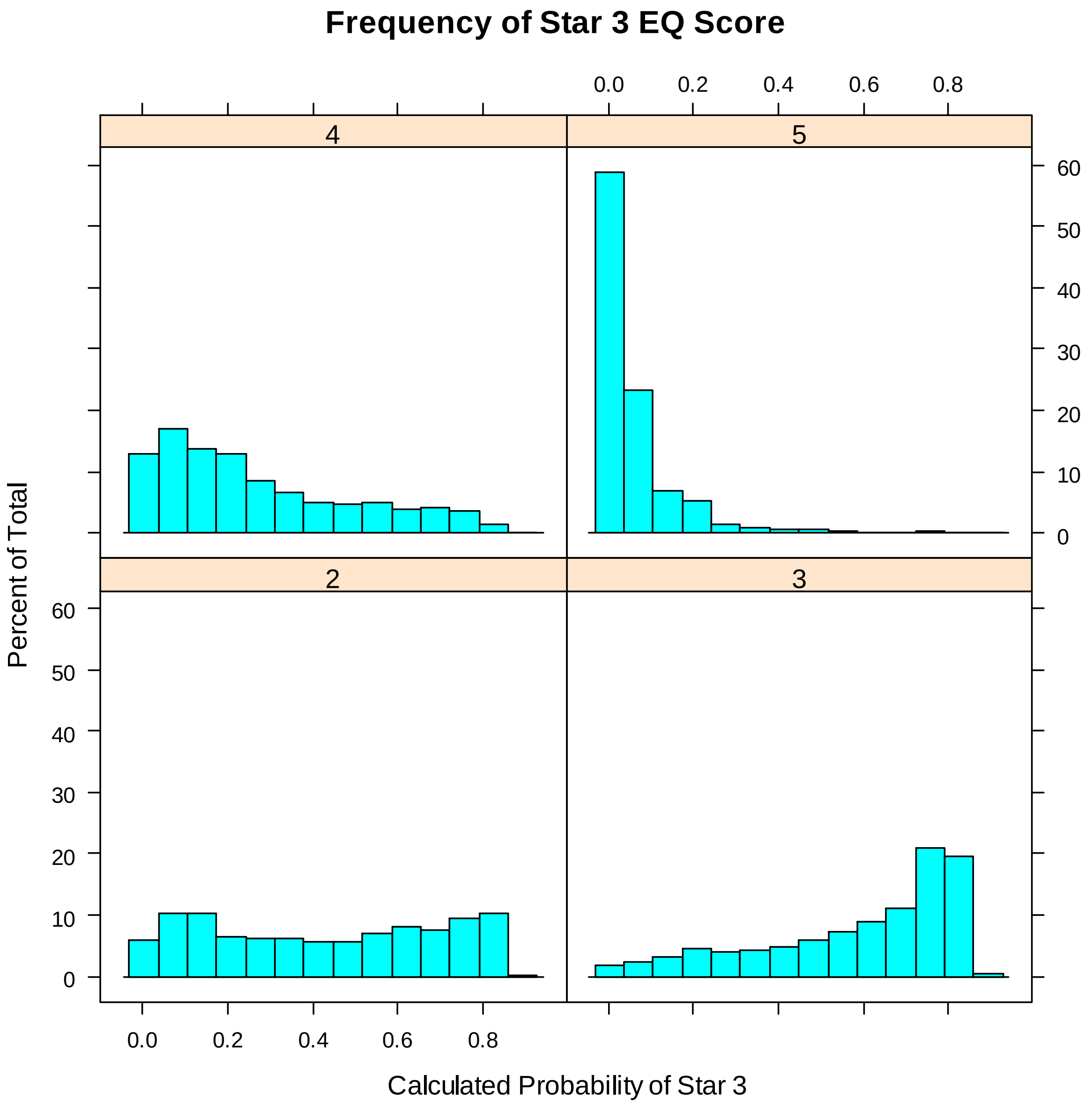
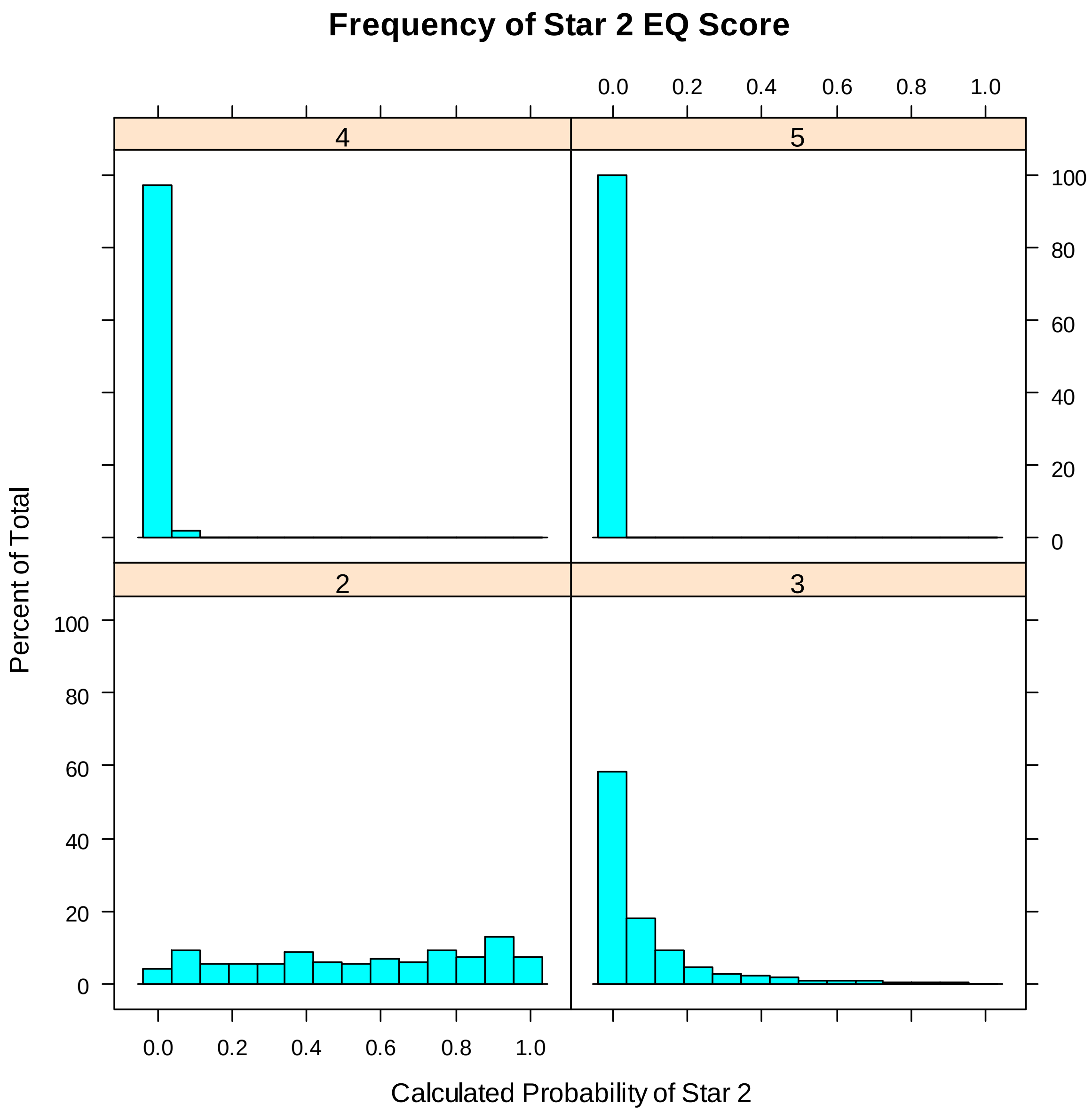


Figure 6.3. Histograms for sheep meat with Consumer Star rating 2 and the frequency of classification by the optimal discriminant function for the loin cut



Milestones 4 and 5

The Relationship between Overall Liking and Tenderness, Juiciness and Flavour

The regression coefficients for the Loin and the Topside relating overall liking to the other sensory variables tenderness, juiciness and flavour are shown in Table 1.5. The regression formed from these coefficients was used to calculate the residuals for Overall Liking presumed to describe those aspects of eating quality not captured in Tenderness, Juiciness and Flavour. These estimates are similar to the estimates for year 2010 reported earlier.

Effect of Year, Sire Breed, Kill Group and Sire on the Sensory Variables

Table 2.5 shows the differences between years for Smell, Tenderness, Juiciness, Flavour, Overall Liking and the residuals on Overall Liking for the Loin and the Topside cuts. Tenderness is marginally better ($P < 0.05$) in year 2009, while Smell, Juiciness, Flavour and Overall Liking were unaffected. However, the residuals on Overall Liking were highly significantly ($P < 0.001$) greater in year 2009. This implies that an aspect of eating quality not captured in Tenderness, Juiciness or Flavour differed between years. The size of this difference presented in Table 1.5 suggests an important as well as a significant effect. However this effect cannot be identified in the current analysis

The Topside cut showed greater between year differences, notably for Juiciness and Flavour, although the residual on Overall Liking was unaffected. The sources of these effects are not apparent.

The sheep meat from drop 2010 was consistently estimated as poorer quality than for drop 2009. However, the existence of extra breeds (Dorper and White Dorper) and a suite of different sires in year 2010 make this difference difficult to interpret.

Table 3.5 shows the variance components for the random effects for the Loin and the Topside cuts. The variance in the sensory variables associated with sires is higher in the Loin than in the Topside, but still small. The intraclass correlations are 0.09 for Tenderness and 0.06 for Overall Liking. In the Topside Overall Liking has an intraclass correlation of 0.08. The variance components for the sensory variables associated with Kill Group is also low, suggesting that kill group is not an important source of variation.

The major source of variation in the sensory variables is associated with consumer variation, and appears to be associated with consumers using different reference points in their assessment of meat quality. This issue and the asymmetric nature of consumer judgement of eating quality have been well canvassed in earlier reports to the MLA on this project. Clipping the data based on the residuals for overall liking alleviated this effect.

Tables 4.5 and 5.5 give the least squares means for the sire breeds for the Loin and Topside cuts respectively. Tables 6.5 and 7.5 present the significant ($P < 0.05$) sire breed comparisons for the Loin and Topside cuts respectively. There were no sire breed effects for the residuals on Overall Liking. That is, there were no sire breed effects for eating quality that were not related to tenderness, juiciness or flavour.

Tables 8.5 and 9.5 show the least squares means for the sire breeds when the variables intramuscular fat, linear and quadratic and shear force 5. Intramuscular fat, linear and quadratic has a significant ($P < 0.05$) on all the sensory variables for the Loin cut, but only for flavour for the Topside cut. Shear force 5 measurements are significantly ($P < 0.05$) related to all the sensory variables in both Loin and Topside cuts. Inclusion of these covariates did not materially alter the relationships between the sire breeds.

Table 10.5 shows the BLUP estimates for the sires within sire breed and the ranking of these sires for the Loin cut. Table 11.5 shows the BLUP estimates for the sires within sire breed and the ranking of these sires for the Topside cut. Table 12.5 gives the correlations between the ranks of the sire BLUP estimates for each cut and sensory variable. These correlations are uniformly high suggesting an underlying stability in the allocation of an eating quality index to differences between sires.

The Effect of Consumer Star Rating on the Year, Sire Breed, Kill Group and Sire.

Table 13.5 shows the variance components for the logit analysis of star classifications 2 and 3 (standard quality) *verses* star classifications 4 and 5 (excellent quality). Notably the variance components for sire within sire breed for star 4 *verses* star 5 are effectively zero.

The comparisons of star classifications 2 and 3 (judged low eating quality) with star classifications 4 and 5 (judged high eating quality) for each of the 2 years of measurement for each cut are shown in Table 14.5

Table 15.5 presents the logit estimates for the sire breeds for star classifications 2 and 3 *verses* star classifications 4 and 5 for the loin and topside cuts. Table 16.5 gives the specific significant differences between breeds. There was no significant sire breed differences in the proportions classified as star 5 compared to star 4.

Tables 17.5 and 18.5 give the sire BLUP estimates and the ranking for the logit analysis of star classifications 2 and 3 *verses* star classifications 4 and 5 for the Loin and Topside cuts respectively. As the sire variance component for the logit analysis of star 4 *verses* star 5 for both meat cuts was zero these BLUP estimates were irrelevant and not presented.

Discriminant Analysis

The optimal linear discriminant function of tenderness, juiciness flavour and overall liking for the loin cut is

$$\text{Stars} = 0.0234(\text{tender}) + 0.0150(\text{juicy}) + 0.0471(\text{flavour}) + 0.0645(\text{residuals overall liking})$$

This means that a change in flavor and in the consumer judgement of eating quality by overall liking independent of tender, juicy and flavor had approximately twice the impact of tenderness or juiciness on the star classification. For the topside cut the optimal linear discriminant function is

$$\text{Stars} = 0.0284(\text{tender}) + 0.0118(\text{juicy}) + 0.0330(\text{flavour}) + 0.0531(\text{residuals overall liking})$$

Where the relative impacts of tenderness, jiciness, flavor and residuals on overall liking on the star classification are similar to that of the loin cut. The numbers and percentages for the loin and topside cuts successfully classified using the optimal discriminant functions is given in Table 19.5

Table 20.5 shows the multinomial logit estimates for each cut for predicting the star classification of sheep meat using data on the sensory variables tenderness, juiciness flavour and the residual on overall liking after fitting tenderness, juiciness and flavour. The advantage of the logit formulation of discriminant analysis is that the probabilities of a meat sample with a set of measurements of the sensory variables can be calculated. The method of calculation using logits was set out in an earlier report of this project, and is repeated here for completeness.

To calculate the probabilities of a meat sample being in a given star rating given the values of the EQ variables tender, juicy, flavour and overall liking the procedure is:

5. Calculate exp(Intercept + b_1 tender + b_2 juicy + b_3 flavour + b_4 overall liking) for each of the 3 logit regression in Table 20. For example, for tender = 60; juicy = 70; flavour = 65 and overall liking = 70 then for star 3 for the loin exp(-4.2989 + 0.0310 x 60 + 0.0206 x 70 + 0.0783 x 65 + 0.1084 x 70) = 78.9962
6. Sum these results for each star rating case. 78.9962 + 54.7293 + 2.4473 = 136.1729
7. The probability of being in the reference star rating (star 2) given the values for the EQ variables is $\frac{1}{1+136.1729}$ = 0.007.
8. The probability of being in each of the other star rating is the value of exp(regression) as calculated in item (1) divided by 1 + the sum. For the probability of the example being in start 3 this is $\frac{78.9962}{1+136.1729}$ = 0.58. Similar calculations for show that the probability of being in star 4 is 0.40, and in star 5 is 0.02 for the given values of the EQ variables.
9.

Analysis of Clipped Data

The analysis made clear that between consumer variations in their judgements of meat eating quality was a problem, in particular the existence of different references points for different consumers and the asymmetric nature of some of the judgements introduced variation that tended to obscure important features of biological interest. To address this situation the data was 'clipped' by calculating the residuals from the analysis of Overall Liking and eliminating all those observations with an absolute value greater than 10 units.

Table 21.5 shows the variance components for the loin and topside cuts for the analysis of the clipped data. The sire intraclass correlation goes from 0.06 in the full data set to 0.23 in the clipped data set for the loin, and from 0.08 in the full data set to 0.31 in the clipped data set in the Topside. Table 22.5 gives the sire BLUP estimates and their ranks for the discriminant function for the clipped data for the loin and topside cuts. The correlation of the ranks for each cut was 0.81.

Relationship of Sire Best Linear Unbiased Predictions to Carcass Variables Best Linear Unbiased Predictions

It should be noted that the variance components for the sire effects on the sensory variables are relatively low. Thus it should not be expected that the impact of a particular sire on meat eating quality would be high, or even noticeable, when compared with other factors such as the consumer effect. In this respect there is insufficient variation associated with a sire effect to classify sheep meat eating quality on this basis.

Table 22.5 shows the sire BLUPs corrected for deviations due to sire breed for each of the sensory variables and for the linear discriminant function. The sires in Table 22.5 are ranked by the value of the linear discriminant function, showing the preference of consumers for the progeny of particular sires. It is clear that sires of the Merino breed are ranked high and sires of the Poll Dorset breed are ranked low. However, sire ranks are confounded to some extent by the variation in consumer judgement where subclass numbers for particular sires are low as previously noted. The correlation between the 10% clipped discriminant function for each loin and topside cut was 0.63. The correlation between the ranks of the 10% clipped discriminant function for each loin and topside cut was 0.33.

The correlation between the sire BLUPs (corrected for sire breed) for the 10% clipped loin discriminant function and the sire BLUPs for the probability that a meat cut would be classified as star 4 or star 5 was 0.26 ($P < 0.01$)for the loin and 0.28 ($P < 0.01$) for the topside. This means that the sire BLUP values for the 10% clipped discriminant function were moderately related to the consumer judgement of eating quality in terms of discriminating those sires producing meat of better eating quality.

Tables 23.5 and 24.5 show the probabilities (frequencies) calculated from estimates of the logits that a given sire of a given breed will produce progeny with meat eating quality classified in one of the star ratings. Rounding errors mean that the sums across all star classifications may not add to 100%. These probabilities were calculated for each meat cut using the equations in Table 20.5.

Meat Colour Measurements

Table 25.5 shows the variance components for the 3 colour measurements, CFL, CFa and CFb. The differences between the loin and topside cuts for these measurements were less than 10^{-16} units, so the results for both cuts are combined. Table 25.5 shows very strong sire effects on meat colour, with intraclass correlations from Table 25 of 0.65 for CFL, 0.73 for CFa, and 0.67 for CFb. Table 26.5 presents the sire breed effects for these colour measurements and Table 27.5 shows the significant sire breed comparisons. It can be seen the only significant sire breed effect is due to the Prime Samm breed having stronger meat colour measurements than other breeds for CFL and CFa. There were no significant sire breed effects for meat colour measurement CFb.

Table 28.5 shows the sire BLUP estimates and their ranks for each of the meat colour measurements. The size of the intraclass correlations indicates that there are considerable sire within sire breed effects for these traits.

Table 29.5 and Table 30.5 give the correlations between the sire BLUP values for the optimal linear discriminant function and the sire BLUP values for several important carcass attributes. It shows that intramuscular fat and shear force 5 sire BLUP values are not related to the discriminant function sire BLUP values, suggesting that these aspects of meat quality are not related to sire differences. CEMA, the fat measurements and LMY are moderately correlated indicating sire differences in discriminating sheep meat eating quality are associated with these variables.

There was a significant ($P < 0.02$) relationship between the sire BLUP for the amount of intramuscular fat in a loin cut and the sire BLUP for the probability (frequency) with which that cut would be graded as high eating quality (star 4 or star 5). The correlation was $r = 0.15$. However, though the relationship was significant the predictability was low

Discussion

The most notable aspect of this analysis is the small between year effects. This meant that the results for the combined years 2009 and 2010 were very similar. The year 2010 introduced a range of different sires and 2 new sire breeds (Dorper and White Dorper), however the results remained consistent. This is encouraging since it suggests that a program for improving sheep meat eating quality based on manipulating genetics would be stable between years.

The association of meat colour with the sire is notably strong and would clearly respond to selection if required. The propensity for the Prime Samm breed to have a stronger colour measurement than that of the other breeds is also clear.

The same difficulties with asymmetric consumer judgements persisted in year 2010, adding evidence to the suggestion in earlier reports that this is a fact about the sheep meat customer base. A separate paper formally presenting these results may be useful in calling the attention of professionals in marketing and consumer studies to this issue.

Using clipped data by discarding those observations with overall liking residuals greater than 10 units markedly improved the proportion of variance attributed to the sire effect. It is presumed that clipping the data in this way removed disturbances due to the more extreme asymmetric consumer judgements, and thus presented a more realistic association between genetics and meat eating quality

Table 1.5. Regression coefficients for Overall Liking on Tenderness, Juiciness and Flavour for Loin and Topside cuts

	Loin	Topside
Intercept	2.033 ± 0.252	0.126 ± 0.218
Tenderness	0.206 ± 0.005	0.298 ± 0.005
Juiciness	0.136 ± 0.005	0.154 ± 0.006
Flavour	0.648 ± 0.005	0.551 ± 0.006

Table 2.5. Least Squares estimates for the Year Effect of the Sensory Variables for the Loin and the Topside Cuts

Cut	Year	Smell	Tender	Juicy	Flavour	Overall Liking	Residual Overall Liking
Loin	2009	69.5 ± 0.60	76.0* ± 1.12	69.5 ± 1.15	72.3 ± 0.87	73.8 ± 0.95	2.12*** ± 0.36
	2010	69.9 ± 0.54	72.1 ± 1.02	66.6 ± 1.04	70.9 ± 0.79	71.9 ± 0.86	0.26 ± 0.33
Top Side	2009	67.0 ± 0.57	52.1* ± 1.81	52.5*** ± 1.27	58.4** ± 1.08	55.9 ± 1.39	0.10 ± 0.20
	2010	65.5 ± 0.51	46.9 ± 1.62	46.2 ±1.15	54.2 ± 0.98	51.2 ± 1.26	0.01 ± 0.18

Table 3.5: The variance components for the random effects for the Loin and Topside cuts.

Cut	Random Effect	Smell	Tender	Juicy	Flavour	Overall
Loin	Consumer within Pick	156.7	136.6	182.7	155.1	147.2
	Pick	8.9	9.6	10.9	7.8	8.3
	Sire with sire breed within Kill group:	0.36	21.8	15.5	8.2	14.6
	Kill group	0.14	2.7	2.8	1.4	1.8
	Residual	159.9	231.2	259.9	235.5	220.5
Topside	Consumer within Pick	179.8	178.5	206.0	187.2	180.2
	Pick	8.6	9.6	10.7	9.5	9.1
	Sire with sire breed within Kill group:	0.0	0.0	22.5	15.6	26.5
	Kill group	0.0	9.4	4.0	2.5	5.1
	Residual	176.1	380.0	308.4	288.8	304.3

Table 4.5. The least squares means and standard errors for the sire breed for the Loin cut for each of the sensory variables

Sire Breed	Smell	Tender	Juicy	Flavour	Overall Liking	Residual Overall Liking
Bond	71.7 ± 2.28	77.5 ± 3.55	73.1 ± 3.51	73.6 ± 3.03	77.1 ± 3.22	1.82 ± 0.94
Border Leicester	70.5 ± 0.74	74.9 ± 1.37	68.9 ± 1.35	71.4 ± 1.08	73.7 ± 1.18	0.59 ± 0.27
Coopworth	69.2 ± 0.74	73.1 ± 1.35	67.1 ± 1.33	71.1 ± 1.07	72.3 ± 1.16	-0.09 ± 0.27
Corriedale	70.1 ± 0.71	76.7 ± 1.36	70.5 ± 1.33	73.6 ± 1.05	75.2 ± 1.15	0.24 ± 0.26
Dohne Merino	70.3 ± 0.69	76.0 ± 1.31	68.9 ± 1.29	72.6 ± 1.02	74.1 ± 1.11	0.01 ± 0.25
Dorper	70.4 ± 1.14	74.4 ± 3.06	66.7 ± 2.85	71.3 ± 2.14	73.3 ± 2.51	0.45 ± 0.43
Merino	70.2 ± 0.62	76.7 ± 1.24	70.6 ± 1.23	73.5 ± 0.93	75.5 ± 1.02	0.31 ± 0.21
Poll Dorset	69.6 ± 0.52	68.4 ± 1.06	63.4 ± 1.05	68.4 ± 0.79	68.7 ± 0.87	-0.28 ± 0.16
Poll Merino	70.3 ± 0.66	76.4 ± 1.30	70.4 ± 1.28	73.3 ± 0.98	74.9 ± 1.08	0.04 ± 0.22
Prime Samm	69.9 ± 0.67	78.9 ± 1.23	73.1 ± 1.22	75.2 ± 0.96	76.7 ± 1.05	0.24 ± 0.24
Suffolk	68.4 ± 0.71	74.2 ± 1.38	67.7 ± 1.34	71.5 ± 1.06	72.4 ± 1.17	-0.20 ± 0.26
Texel	68.2 ± 0.75	70.1 ± 1.43	64.6 ± 1.40	68.2 ± 1.10	68.9 ± 1.22	-0.52 ± 0.28
White Dorper	70.3 ± 0.82	77.4 ± 2.35	69.8 ± 2.23	72.4 ± 1.60	74.5 ± 1.86	0.30 ± 0.28
White Suffolk	69.1 ± 0.56	71.5 ± 1.07	65.8 ± 1.07	70.4 ± 0.82	71.2 ± 0.90	0.01 ± 0.18

Table 5.5. The least squares means and standard errors for the sire breed for the Topside cut for each of the sensory variables

Sire Breed	Smell	Tender	Juicy	Flavour	Overall Liking	Residual Overall Liking
Bond	71.1 ± 2.30	48.8 ± 2.30	49.8 ± 3.82	60.8 ± 3.50	58.4 ± 3.91	2.41 ± 1.19
Border Leicester	66.9 ± 0.75	51.4 ± 0.75	51.4 ± 1.44	57.8 ± 1.28	55.5 ± 1.52	0.21 ± 0.36

Coopworth	66.6 ± 0.75	49.4 ± 0.75	48.7 ± 1.43	57.0 ± 1.27	53.7 ± 1.51	-0.14 ± 0.36
Corriedale	67.2 ± 0.71	52.6 ± 0.71	51.6 ± 1.41	57.6 ± 1.25	55.2 ± 1.49	-0.38 ± 0.34
Dohne Merino	66.3 ± 0.70	50.7 ± 0.70	49.3 ± 1.37	56.4 ± 1.21	54.1 ± 1.45	0.04 ± 0.33
Dorper	67.1 ± 1.08	51.1 ± 1.08	52.2 ± 3.06	57.9 ± 2.65	55.5 ± 3.27	0.28 ± 0.56
Merino	66.0 ± 0.61	51.1 ± 0.61	49.4 ± 1.22	56.4 ± 1.08	53.8 ± 1.30	-0.46 ± 0.28
Poll Dorset	65.2 ± 0.51	43.9 ± 0.51	45.7 ± 1.08	52.8 ± 0.94	49.4 ± 1.16	0.11 ± 0.22
Poll Merino	65.7 ± 0.65	50.2 ± 0.65	48.9 ± 1.31	56.9 ± 1.15	54.3 ± 1.38	0.31 ± 0.30
Prime Samm	66.4 ± 0.67	53.5 ± 0.67	52.4 ± 1.29	58.6 ± 1.14	57.2 ± 1.36	0.73 ± 0.31
Suffolk	66.2 ± 0.71	49.5 ± 0.71	49.3 ± 1.44	56.7 ± 1.27	53.8 ± 1.51	0.10 ± 0.34
Texel	66.9 ± 0.76	46.4 ± 0.76	47.9 ± 1.49	55.2 ± 1.32	51.6 ± 1.57	-0.03 ± 0.36
White Dorper	67.2 ± 0.74	52.1 ± 0.74	51.4 ± 2.27	57.1 ± 1.95	55.4 ± 2.45	0.64 ± 0.39
White Suffolk	65.7 ± 0.55	47.6 ± 0.54	47.6 ± 1.11	55.1 ± 0.97	51.7 ± 1.19	-0.34 ± 0.24

Table 6.5. Significant ($P < 0.05$) sire breed comparisons for the Loin cut for each of the sensory variables.

Loin Tender

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Border Leicester	-6.45	0.01
Poll Dorset	v	Corriedale	-8.27	0.01
Texel	v	Corriedale	-6.63	0.01
Poll Dorset	v	Dohne Merino	-7.58	0.01
Poll Dorset	v	Merino	-8.29	0.01
Texel	v	Merino	-6.65	0.01
White Suffolk	v	Merino	-5.24	0.01
Poll Merino	v	Poll Dorset	8.00	0.01
Prime Samm	v	Poll Dorset	10.48	0.01
Suffolk	v	Poll Dorset	5.76	0.01
Texel	v	Poll Merino	-6.36	0.01
Texel	v	Prime Samm	-8.84	0.01
White Suffolk	v	Prime Samm	-7.43	0.01
Prime Samm	v	Coopworth	5.77	0.01

White Suffolk	v	Corriedale	-5.21	0.02
White Dorper	v	Poll Dorset	8.97	0.02
White Suffolk	v	Poll Merino	-4.95	0.02
Texel	v	Dohne Merino	-5.94	0.02
Poll Dorset	v	Coopworth	-4.71	0.05

Juicy

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Border Leicester	-5.54	0.01
Prime Samm	v	Coopworth	6.02	0.01
Poll Dorset	v	Corriedale	-7.10	0.01
Poll Dorset	v	Dohne Merino	-5.54	0.01
Poll Dorset	v	Merino	-7.22	0.01
Texel	v	Merino	-6.04	0.01
Poll Merino	v	Poll Dorset	7.02	0.01
Prime Samm	v	Poll Dorset	9.71	0.01
Texel	v	Prime Samm	-8.53	0.01
White Suffolk	v	Prime Samm	-7.29	0.01
White Suffolk	v	Merino	-4.80	0.01
Texel	v	Poll Merino	-5.84	0.01
Suffolk	v	Prime Samm	-5.46	0.02
Texel	v	Corriedale	-5.93	0.02
White Suffolk	v	Poll Merino	-4.60	0.03
White Suffolk	v	Corriedale	-4.69	0.04

Flavour

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Corriedale	-5.20	0.01
Texel	v	Corriedale	-5.35	0.01
Poll Dorset	v	Dohne Merino	-4.27	0.01
Poll Dorset	v	Merino	-5.13	0.01
Texel	v	Merino	-5.27	0.01
Poll Merino	v	Poll Dorset	4.89	0.01
Prime Samm	v	Poll Dorset	6.78	0.01
Texel	v	Poll Merino	-5.03	0.01
Texel	v	Prime Samm	-6.92	0.01
White Suffolk	v	Prime Samm	-4.76	0.01
Texel	v	Dohne Merino	-4.41	0.03
Prime Samm	v	Coopworth	4.04	0.04

Overall

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Border Leicester	-5.01	0.01
Poll Dorset	v	Corriedale	-6.54	0.01
Texel	v	Corriedale	-6.29	0.01
Poll Dorset	v	Dohne Merino	-5.49	0.01
Poll Dorset	v	Merino	-6.88	0.01
Texel	v	Merino	-6.63	0.01
White Suffolk	v	Merino	-4.36	0.01
Poll Merino	v	Poll Dorset	6.27	0.01
Prime Samm	v	Poll Dorset	8.01	0.01
Texel	v	Poll Merino	-6.01	0.01
Texel	v	Prime Samm	-7.76	0.01
White Suffolk	v	Prime Samm	-5.49	0.01
Texel	v	Dohne Merino	-5.23	0.01
White Suffolk	v	Corriedale	-4.02	0.05
Prime Samm	v	Coopworth	4.38	0.05
White Suffolk	v	Poll Merino	-3.74	0.05

Table 7.5 Significant (P < 0.05) sire breed comparisons for the Topside cut for each of the sensory variables.

Tender

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Border Leicester	-7.55	0.01
Poll Dorset	v	Corriedale	-8.75	0.01
Poll Dorset	v	Dohne Merino	-6.82	0.01
Poll Dorset	v	Merino	-7.20	0.01
Poll Merino	v	Poll Dorset	6.35	0.01
Prime Samm	v	Poll Dorset	9.64	0.01
White Suffolk	v	Prime Samm	-5.86	0.01
Texel	v	Prime Samm	-7.09	0.01
Suffolk	v	Poll Dorset	5.67	0.04
Poll Dorset	v	Coopworth	-5.49	0.05

Juicy

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Border Leicester	-5.65	0.01
Poll Dorset	v	Corriedale	-5.93	0.01
Prime Samm	v	Poll Dorset	6.73	0.01
White Suffolk	v	Prime Samm	-4.85	0.01

Flavour

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Border Leicester	-5.00	0.01
Poll Dorset	v	Corriedale	-4.81	0.01
Prime Samm	v	Poll Dorset	5.74	0.01
Poll Merino	v	Poll Dorset	4.11	0.02
Poll Dorset	v	Merino	-3.63	0.04
Poll Dorset	v	Coopworth	-4.19	0.05

Overall Liking

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Border Leicester	-6.06	0.01
Poll Dorset	v	Corriedale	-5.77	0.01
Prime Samm	v	Poll Dorset	7.73	0.01
White Suffolk	v	Prime Samm	-5.50	0.01
Poll Merino	v	Poll Dorset	4.84	0.01

Poll Dorset	v	Merino	-4.33	0.02
Poll Dorset	v	Dohne Merino	-4.63	0.04
Texel	v	Prime Samm	-5.57	0.04

Table 8.5. Least squares means and standard error for sire breed for the Loin cut including covariables intramuscular fat and shear force 5.

Sire Breed	Smell	Tender	Juicy	Flavour	Overall Liking
Bond	71.4 ± 2.27	77.3 ± 3.34	72.5 ± 3.39	73.4 ± 2.91	76.8 ± 3.03
Border Leicester	70.5 ± 0.75	74.9 ± 1.34	69.2 ± 1.36	71.5 ± 1.05	73.8 ± 1.15
Coopworth	69.3 ± 0.74	73.1 ± 1.31	67.2 ± 1.34	71.2 ± 1.04	72.4 ± 1.13
Corriedale	70.3 ± 0.71	77.1 ± 1.31	71.1 ± 1.34	74.0 ± 1.01	75.7 ± 1.12
Dohne Merino	70.2 ± 0.70	75.5 ± 1.28	68.4 ± 1.31	72.2 ± 0.99	73.6 ± 1.09
Dorper	70.1 ± 1.14	73.0 ± 2.80	65.9 ± 2.68	70.9 ± 1.94	72.4 ± 2.26
Merino	70.2 ± 0.63	76.7 ± 1.21	70.6 ± 1.24	73.3 ± 0.90	75.5 ± 1.00
Poll Dorset	70.1 ± 0.54	69.9 ± 1.06	64.7 ± 1.10	69.5 ± 0.79	70.0 ± 0.88
Poll Merino	70.2 ± 0.66	76.5 ± 1.26	70.3 ± 1.29	73.1 ± 0.95	74.8 ± 1.05
Prime Samm	69.2 ± 0.68	76.9 ± 1.23	71.3 ± 1.26	73.7 ± 0.96	75.0 ± 1.05
Suffolk	68.4 ± 0.71	73.9 ± 1.32	67.5 ± 1.34	71.1 ± 1.02	71.1 ± 1.13
Texel	68.7 ± 0.76	71.3 ± 1.38	65.7 ± 1.40	69.3 ± 1.07	70.2 ± 1.17
White Dorper	70.0 ± 0.85	76.4 ± 2.22	68.9 ± 2.17	71.8 ± 1.50	73.7 ± 1.74
White Suffolk	69.1 ± 0.57	71.8 ± 1.07	66.0 ± 1.11	70.5 ± 0.82	71.4 ± 0.90
Covariates					
Intra – muscular fat	1.74 ± 0.89*	4.13 ± 1.30*	4.73 ± 1.33**	4.93 ± 1.16**	5.16 ± 1.20**
IM Fat quadratic	-0.11 ±.09	-0.26 ± 0.13*	-0.28 ± 0.13	-0.36 ± 0.11**	-0.36 ± 0.12*
Shear force 5	-0.08 ± 0.02**	-0.28 ± 0.03***	-0.17 ± 0.03***	-0.17 ± 0.02***	-0.20 ± 0.03***

Table 9.5. Least squares means and standard error for sire breed for the Topside cut including covariables intramuscular fat and shear force 5.

Sire Breed	Smell	Tender	Juicy	Flavour
Bond	71.2 ± 2.32	48.0 ± 4.43	49.2 ± 3.77	60.8 ± 3.48
Border Leicester	66.9 ± 0.76	51.2 ± 1.84	51.3 ± 1.46	57.6 ± 1.30
Coopworth	66.6 ± 0.76	49.3 ± 1.82	48.8 ± 1.44	57.1 ± 1.29
Corriedale	67.3 ± 0.72	52.9 ± 1.80	52.0 ± 1.42	57.9 ± 1.26
Dohne Merino	66.2 ± 0.71	50.2 ± 1.77	48.0 ± 1.39	56.3 ± 1.23
Dorper	67.1 ± 1.12	50.2 ± 3.87	51.5 ± 3.01	57.5 ± 2.63
Merino	65.9 ± 0.63	51.0 ± 1.61	49.4 ± 1.24	56.4 ± 1.10
Poll Dorset	65.3 ± 0.53	44.8 ± 1.47	46.5 ± 1.12	53.4 ± 0.97
Poll Merino	65.6 ± 0.67	50.3 ± 1.69	48.8 ± 1.32	56.8 ± 1.17
Prime Samm	66.3 ± 0.69	51.9 ± 1.69	51.1 ± 1.33	57.8 ± 1.17
Suffolk	66.2 ± 0.72	49.4 ± 1.83	49.2 ± 1.44	56.5 ± 1.27
Texel	67.1 ± 0.78	47.4 ± 1.90	49.0 ± 1.50	55.8 ± 1.34
White Dorper	67.2 ± 0.78	51.7 ± 2.98	51.0 ± 2.27	56.8 ± 1.97
White Suffolk	65.7 ± 0.56	47.8 ± 1.49	47.7 ± 1.14	55.0 ± 0.99
Covariates				
Intra – muscular fat	1.54 ± 0.93	0.62 ± 1.71	2.38 ± 1.50	3.36 ± 1.40*
IM Fat quadratic	-0.14 ± 0.09	0.05 ± 1.17	-0.01 ± 0.01	-0.26 ± 0.14
Shear force 5	-0.02 ± 0.02	-0.21 ± 0.03 **	-0.01 ± 0.003**	-0.08 ± 0.03**

Table 10.5. The BLUP estimates for the sires within sire breed and their ranking for the Loin cut.

Sire Number	Breed	Tender	Rank Tender	Juicy	Rank Juicy
s0600032006060121	Bond	77.5	39	73.3	5
s0237802008080157	Border	76.6	62	71.0	35

	Leicester				
s0244112006060369	Border Leicester	76.5	63	70.6	47
s020041200707J039	Border Leicester	76.5	64	69.9	68
s0236912008088370	Border Leicester	75.4	83	69.2	84
s0219292007070261	Border Leicester	75.3	87	68.9	92
s0246862007070179	Border Leicester	74.3	107	68.8	94
s0247152008080085	Border Leicester	73.8	113	68.1	105
s0236662006060976	Border Leicester	73.2	116	67.6	114
s0241662008080220	Border Leicester	72.8	123	67.2	121
s0250022008085029	Border Leicester	72.7	126	67.2	122
s1500622006060070	Coopworth	75.3	86	68.6	98
s1500292008080181	Coopworth	74.6	100	67.9	108
s1500392006061009	Coopworth	74.6	103	67.5	116
s1500292007070244	Coopworth	74.4	105	67.5	117
s1500992007071449	Coopworth	72.9	121	66.8	126
s1500152003030196	Coopworth	72.5	131	66.6	130
s1500482007070769	Coopworth	71.9	140	66.3	137
s1500482008080808	Coopworth	69.5	164	65.4	149
s0319232001011072	Corriedale	78.5	17	72.4	18
s0300362005050134	Corriedale	78.5	20	72.3	19
s0323612006060209	Corriedale	78.1	23	71.0	36
s0318972008080282	Corriedale	77.2	43	70.4	50
s0324012007070002	Corriedale	76.4	66	70.1	60
s0315272003030360	Corriedale	76.2	68	70.1	61
s0300182004045220	Corriedale	75.4	84	70.0	64
s0314602006543022	Corriedale	75.3	85	69.7	71
s0318972006060386	Corriedale	75.1	89	69.0	89
s0322722008080072	Corriedale	73.0	120	67.6	113
s5100492007071700	Dohne Merino	77.6	35	70.0	65
s5100072008084048	Dohne Merino	77.4	40	69.4	80
s5101402006060368	Dohne Merino	77.1	46	69.1	85
s5100072008083953	Dohne Merino	76.6	61	69.1	87
s5100732007070006	Dohne Merino	76.0	72	69.1	88
s5101462007070128	Dohne Merino	76.0	73	69.0	91
s5100092007070376	Dohne Merino	75.9	74	68.8	93
s5100292008088124	Dohne Merino	75.2	88	68.5	101

s5100032007070949	Dohne Merino	74.6	102	68.2	103
s5100302005050068	Dohne Merino	73.1	118	66.8	127
s4000302007071209	Dorper	76.8	56	69.7	72
s4000302007070056	Dorper	76.4	65	67.7	111
s4000302007070617	Dorper	72.6	127	65.3	150
s5000872006060096	Merino	80.7	2	73.9	4
s5037892007LB0753	Merino	79.8	6	73.2	8
s5047432000000503	Merino	79.4	8	72.8	11
s5007882007071254	Merino	78.4	21	72.8	13
s5034252006060205	Merino	78.1	24	72.7	15
s5038632006OL3626	Merino	77.9	28	72.1	20
s5030972005051737	Merino	77.8	30	72.0	21
s5018852006TRIMPH	Merino	77.7	31	71.9	22
s5015522006060480	Merino	77.7	32	71.6	25
s5044702006060022	Merino	77.6	33	71.4	28
s5030542004040585	Merino	77.5	36	71.4	29
s5030702008080121	Merino	77.5	37	71.3	30
s5007882008081290	Merino	77.5	38	71.3	31
s5049162007070719	Merino	77.2	41	71.2	33
s50505020080G0856	Merino	77.1	45	70.9	38
s5046152004040024	Merino	77.1	47	70.7	40
s5017042007L68007	Merino	77.0	48	70.7	41
s5035642007WHI393	Merino	77.0	49	70.6	44
s5039822006060225	Merino	77.0	51	70.6	45
s5000482007070260	Merino	77.0	52	70.6	46
s5022512006066030	Merino	76.9	54	70.4	49
s5023022006006580	Merino	76.7	58	70.3	55
s5043622006LON449	Merino	76.7	60	70.2	57
s5003182007070022	Merino	76.1	70	70.1	62
s5038842008081981	Merino	75.7	78	70.0	63
s5039462007OLY716	Merino	75.6	80	69.9	66
s5037892008080124	Merino	75.6	81	69.8	69
s5024252006023997	Merino	75.0	91	69.8	70
s5044822007070461	Merino	74.9	92	69.4	79
s50923420060C0573	Merino	74.6	98	69.2	82
s5049022005005345	Merino	74.6	99	68.7	95
s501587200606M276	Merino	74.2	109	67.6	112
s5044702008080588	Merino	74.1	112	67.2	123
s5049162008080600	Merino	70.4	154	67.0	125
s1622882007070644	Poll Dorset	72.7	125	66.5	131
s1637212007070311	Poll Dorset	72.4	134	66.3	136
s1611432008080203	Poll Dorset	71.5	145	66.2	138
s1619722006061831	Poll Dorset	71.3	147	66.1	140
s1600012008080010	Poll Dorset	70.9	152	65.6	147
s1636772008081037	Poll Dorset	70.3	155	64.4	162
s1640732007070364	Poll Dorset	69.9	161	64.1	163
s1640002009090052	Poll Dorset	69.8	163	64.0	164
s1618922006060050	Poll Dorset	69.5	165	64.0	166
s1612352007072025	Poll Dorset	69.4	167	63.7	168
s1627502008080481	Poll Dorset	69.3	168	63.7	169

s1612352008080608	Poll Dorset	69.2	169	63.6	170
s1629472008080219	Poll Dorset	69.2	170	63.6	171
s1611432007070025	Poll Dorset	68.7	172	63.3	172
s1603362008080541	Poll Dorset	68.5	173	63.2	173
s1622882008080077	Poll Dorset	68.4	174	63.1	174
s1619722009090133	Poll Dorset	68.1	175	63.1	175
s1618862008080157	Poll Dorset	67.6	177	62.6	176
s1611582007070190	Poll Dorset	67.5	178	62.3	178
s1614152007070440	Poll Dorset	67.2	179	62.3	179
s1601852007070369	Poll Dorset	66.8	181	62.2	180
s1623682007070468	Poll Dorset	65.5	182	61.7	182
s1600852008080021	Poll Dorset	65.2	183	61.0	183
s1636772007070839	Poll Dorset	63.8	184	60.9	184
s1635282007070182	Poll Dorset	63.7	185	60.8	185
s6013322004000WD 2	Poll Merino	80.5	3	74.4	2
s6010822007071257	Poll Merino	78.9	11	73.3	6
s6013562007000449	Poll Merino	78.6	13	71.8	23
s6012442007070304	Poll Merino	78.5	15	71.5	26
s6008152006060120	Poll Merino	78.1	22	71.5	27
s6008152007070323	Poll Merino	77.9	27	71.0	37
s6010532003031078	Poll Merino	77.8	29	70.9	39
s6011272007070121	Poll Merino	77.2	44	70.6	42
s6012792007070470	Poll Merino	77.0	50	70.6	43
s6013162007070023	Poll Merino	76.9	53	70.5	48
s6091542006060306	Poll Merino	76.8	55	70.4	52
s6004082007070069	Poll Merino	76.8	57	70.4	53
s6010822008081288	Poll Merino	76.7	59	70.4	54
s6008802006060627	Poll Merino	76.3	67	70.2	58
s6012502004407812	Poll Merino	76.1	69	70.2	59
s6013072005050165	Poll Merino	76.0	71	69.9	67
s6010532007071190	Poll Merino	75.8	77	69.6	73
s6013652006060052	Poll Merino	75.6	82	69.6	75
s6005712006060904	Poll Merino	74.9	93	69.6	76
s6013362008RAS004	Poll Merino	74.9	94	69.5	77
s6005712006060058	Poll Merino	74.9	95	69.3	81
s6005532007070002	Poll Merino	74.8	96	69.1	86
s6012882006063091	Poll Merino	74.4	106	69.0	90
s6090542006066533	Poll Merino	73.8	115	68.7	96
s6001052007071080	Poll Merino	72.9	122	68.7	97
s6091542004040062	Poll Merino	72.5	128	68.6	99
s6011272008088254	Poll Merino	72.5	132	68.0	106
s4800402008080217	Prime Samm	80.5	4	74.5	1
s4800392007070062	Prime Samm	79.9	5	74.2	3
s4800552007070068	Prime Samm	79.5	7	73.3	7
s4801222005051010	Prime Samm	79.3	9	73.2	9
s4801222008080343	Prime Samm	78.6	14	72.8	12
s4800872006060421	Prime Samm	78.5	18	72.7	14
s4800302008080078	Prime Samm	78.5	19	72.6	16
s4801042008080549	Prime Samm	78.0	25	72.6	17
s4800302008080111	Prime Samm	77.9	26	71.8	24
s4800992006060191	Prime Samm	75.8	76	70.4	51
s1900282007071494	Suffolk	75.6	79	68.5	100

s1901112007077058	Suffolk	75.0	90	68.2	104
s1920452008080594	Suffolk	74.7	97	67.9	107
s1912012008080094	Suffolk	74.6	104	67.8	109
s1913622007070027	Suffolk	74.2	108	67.8	110
s1918502001010120	Suffolk	74.1	110	67.3	118
s1900602008080369	Suffolk	73.8	114	67.2	120
s1916612008080491	Suffolk	73.2	117	67.1	124
s1900602007070267	Suffolk	73.0	119	66.4	135
s1920452007070508	Suffolk	72.1	137	66.2	139
s1700802007071532	Texel	72.5	133	65.9	142
s1700622007070144	Texel	71.9	139	65.7	144
s1704202007070224	Texel	70.1	156	65.3	153
s1700812008080039	Texel	70.0	157	64.4	161
s1704062007070028	Texel	68.8	171	64.0	165
s1702232007070046	Texel	67.8	176	62.6	177
s1702232004040080	Texel	67.0	180	62.2	181
s4702062007077118	White Dorper	81.1	1	73.0	10
s4700442008084825	White Dorper	79.0	10	71.2	32
s4701392006060057	White Dorper	78.7	12	71.1	34
s4701142007071345	White Dorper	78.5	16	70.3	56
s4700702003030011	White Dorper	77.6	34	69.4	78
s4701792008080386	White Dorper	77.2	42	69.2	83
s4701142006060036	White Dorper	74.6	101	68.5	102
s2301002007070677	White Suffolk	75.9	75	69.6	74
s2300262005050650	White Suffolk	74.1	111	67.5	115
s2300992008080097	White Suffolk	72.7	124	67.3	119
s2300012008080022	White Suffolk	72.5	129	66.7	128
s2304502007071456	White Suffolk	72.5	130	66.7	129
s2301132008080205	White Suffolk	72.3	135	66.5	132
s2303182008080262	White Suffolk	72.3	136	66.5	133
s2300302008080116	White Suffolk	72.0	138	66.4	134
s2300262007072446	White Suffolk	71.8	141	66.0	141
s2300152007070143	White Suffolk	71.8	142	65.8	143
s2300262008083813	White Suffolk	71.6	143	65.7	145
s2300912007070008	White Suffolk	71.5	144	65.6	146
s2301132007070040	White Suffolk	71.3	146	65.5	148
s2300152009090255	White Suffolk	71.2	148	65.3	151
s2303242008085244	White Suffolk	71.1	149	65.3	152
s2300432008080644	White Suffolk	71.0	150	65.2	154
s2300092007070279	White Suffolk	71.0	151	65.2	155
s2300342007074914	White Suffolk	70.9	153	65.1	156
s2300432008080136	White Suffolk	70.0	158	65.1	157
s2303242007075630	White Suffolk	70.0	159	65.1	158
s2300022008080234	White Suffolk	70.0	160	64.9	159
s2300432007070591	White Suffolk	69.9	162	64.8	160
s2300022007070098	White Suffolk	69.5	166	63.9	167

Sire Number	Breed	Flavour	Rank Flavour	Overall Liking	Rank Overall Liking
s0600032006060121	Bond	73.8	44	77.3	9
s020041200707J039	Border Leicester	72.3	88	75.3	52
s0244112006060369	Border Leicester	71.9	101	75.2	57
s0246862007070179	Border Leicester	71.8	102	74.3	78
s0236662006060976	Border Leicester	71.8	103	74.3	79
s0219292007070261	Border Leicester	71.7	107	74.0	85
s0237802008080157	Border Leicester	71.4	118	73.3	103
s0241662008080220	Border Leicester	70.9	120	72.9	109
s0250022008085029	Border Leicester	70.8	126	72.4	117
s0236912008088370	Border Leicester	70.7	130	72.3	118
s0247152008080085	Border Leicester	70.0	146	72.2	120
s1500292008080181	Coopworth	72.1	95	73.6	94
s1500392006061009	Coopworth	71.9	98	73.5	97
s1500622006060070	Coopworth	71.6	110	73.5	99
s1500292007070244	Coopworth	71.4	117	72.7	112
s1500992007071449	Coopworth	70.9	122	71.9	125
s1500152003030196	Coopworth	70.8	128	71.9	126
s1500482007070769	Coopworth	70.5	134	71.7	135
s1500482008080808	Coopworth	69.9	147	70.2	155
s0319232001011072	Corriedale	74.9	9	77.0	13
s0300362005050134	Corriedale	74.3	19	76.9	14
s0314602006543022	Corriedale	74.1	28	75.9	34
s0318972008080282	Corriedale	73.6	47	75.4	49
s0323612006060209	Corriedale	73.6	48	75.2	56
s0324012007070002	Corriedale	73.3	63	74.8	64
s0318972006060386	Corriedale	73.2	66	74.7	68
s0300182004045220	Corriedale	73.1	68	74.0	86
s0322722008080072	Corriedale	72.6	80	73.2	106
s0315272003030360	Corriedale	72.1	96	72.5	116
s5100072008084048	Dohne Merino	73.8	43	75.4	48
s5101462007070128	Dohne Merino	73.5	50	75.1	58
s5100072008083953	Dohne Merino	73.0	70	74.7	69
s5101402006060368	Dohne Merino	72.8	77	74.4	75
s5100092007070376	Dohne	72.8	78	74.3	76

	Merino				
s5100032007070949	Dohne Merino	72.5	84	74.3	77
s5100292008088124	Dohne Merino	72.4	85	73.8	89
s5100732007070006	Dohne Merino	72.4	87	73.8	90
s5100492007071700	Dohne Merino	71.9	99	73.3	104
s5100302005050068	Dohne Merino	71.5	113	72.2	121
s4000302007071209	Dorper	74.4	15	75.6	43
s4000302007070056	Dorper	71.7	106	73.9	88
s4000302007070617	Dorper	69.5	155	72.1	122
s5000872006060096	Merino	75.9	1	78.3	1
s5015522006060480	Merino	75.1	8	78.2	2
s5007882007071254	Merino	74.7	12	77.8	4
s5035642007WHI393	Merino	74.5	14	77.4	8
s5030542004040585	Merino	74.4	16	77.2	12
s5003182007070022	Merino	74.3	21	76.6	18
s5034252006060205	Merino	74.2	23	76.6	19
s5037892007LB0753	Merino	74.2	24	76.6	20
s5047432000000503	Merino	74.1	25	76.5	21
s5018852006TRIMPH	Merino	74.1	26	76.4	22
s5030702008080121	Merino	74.1	27	76.4	23
s5022512006066030	Merino	74.0	30	76.4	24
s5044702006060022	Merino	74.0	32	76.2	27
s5030972005051737	Merino	74.0	33	76.1	28
s5000482007070260	Merino	73.9	37	76.1	29
s5007882008081290	Merino	73.8	39	75.9	37
s5049162007070719	Merino	73.8	41	75.8	38
s5038632006OL3626	Merino	73.7	45	75.7	39
s5023022006006580	Merino	73.5	49	75.7	41
s5039462007OLY716	Merino	73.5	52	75.7	42
s501587200606M276	Merino	73.5	53	75.5	45
s5017042007L68007	Merino	73.4	57	75.5	46
s5043622006LON449	Merino	73.4	58	75.3	50
s5046152004040024	Merino	73.3	60	75.1	60
s5039822006060225	Merino	73.3	61	75.0	61
s5038842008081981	Merino	73.1	67	74.8	66
s5049022005005345	Merino	73.0	69	74.6	71
s5037892008080124	Merino	72.8	79	74.4	73
s5044822007070461	Merino	72.6	82	74.2	80
s50923420060C0573	Merino	72.5	83	73.9	87
s50505020080G0856	Merino	72.4	86	73.6	95
s5049162008080600	Merino	72.3	89	73.4	100
s5024252006023997	Merino	71.8	105	72.7	113
s5044702008080588	Merino	71.5	111	72.3	119
s1622882007070644	Poll Dorset	70.6	132	71.9	127
s1619722006061831	Poll Dorset	70.4	136	71.7	132
s1637212007070311	Poll Dorset	69.8	151	71.6	137
s1640002009090052	Poll Dorset	69.6	154	70.5	151
s1611432008080203	Poll Dorset	69.1	158	70.0	156

s1627502008080481	Poll Dorset	69.1	159	70.0	157
s1611432007070025	Poll Dorset	68.9	160	69.9	158
s1622882008080077	Poll Dorset	68.8	162	69.7	160
s1612352008080608	Poll Dorset	68.8	163	69.6	163
s1618922006060050	Poll Dorset	68.7	164	69.4	164
s1600012008080010	Poll Dorset	68.7	166	69.4	166
s1640732007070364	Poll Dorset	68.7	167	69.3	167
s1611582007070190	Poll Dorset	68.6	168	69.2	168
s1629472008080219	Poll Dorset	68.6	169	69.2	169
s1636772008081037	Poll Dorset	68.5	170	68.9	172
s1603362008080541	Poll Dorset	68.4	171	68.7	173
s1619722009090133	Poll Dorset	68.3	172	68.7	174
s1614152007070440	Poll Dorset	68.3	174	68.3	175
s1618862008080157	Poll Dorset	68.1	176	67.9	176
s1612352007072025	Poll Dorset	67.5	179	67.6	177
s1601852007070369	Poll Dorset	67.4	180	66.9	181
s1623682007070468	Poll Dorset	67.3	181	66.2	182
s1600852008080021	Poll Dorset	67.1	182	65.9	183
s1636772007070839	Poll Dorset	66.6	184	65.7	184
s1635282007070182	Poll Dorset	66.4	185	65.4	185
s6008152006060120	Poll Merino	74.9	10	77.5	6
s6012442007070304	Poll Merino	74.4	18	77.5	7
s6013322004000WD2	Poll Merino	74.3	20	76.3	25
s6010822007071257	Poll Merino	74.0	31	76.1	30
s6005712006060058	Poll Merino	74.0	34	76.0	31
s6010532007071190	Poll Merino	73.9	35	76.0	32
s6011272007070121	Poll Merino	73.9	36	75.9	36
s6013162007070023	Poll Merino	73.8	38	75.7	40
s6004082007070069	Poll Merino	73.8	40	75.6	44
s6013562007000449	Poll Merino	73.8	42	75.3	53
s6010532003031078	Poll Merino	73.6	46	75.2	54
s6001052007071080	Poll Merino	73.5	51	75.2	55
s6090542006066533	Poll Merino	73.5	54	74.9	63
s6008802006060627	Poll Merino	73.4	55	74.8	65
s6091542006060306	Poll Merino	73.4	56	74.7	67
s6005712006060904	Poll Merino	73.3	62	74.6	70
s6008152007070323	Poll Merino	72.9	72	74.4	74
s6012792007070470	Poll Merino	72.9	73	74.2	81
s6012502004407812	Poll Merino	72.8	75	74.1	83
s6005532007070002	Poll Merino	72.8	76	74.1	84
s6013072005050165	Poll Merino	72.6	81	73.8	91
s6010822008081288	Poll Merino	72.2	90	73.7	93
s6013362008RAS004	Poll Merino	72.1	93	73.5	98
s6011272008088254	Poll Merino	71.9	100	73.4	101
s6091542004040062	Poll Merino	71.8	104	73.2	105
s6012882006063091	Poll Merino	71.7	108	72.5	115
s6013652006060052	Poll Merino	71.5	112	71.5	140
s4801222005051010	Prime Samm	75.9	2	78.1	3
s4800402008080217	Prime Samm	75.6	3	77.6	5
s4800302008080111	Prime Samm	75.4	4	77.2	10

s4800552007070068	Prime Samm	75.2	5	76.9	15
s4801222008080343	Prime Samm	75.1	6	76.9	16
s4800392007070062	Prime Samm	75.1	7	76.7	17
s4800302008080078	Prime Samm	74.8	11	76.0	33
s4801042008080549	Prime Samm	74.6	13	75.9	35
s4800872006060421	Prime Samm	74.4	17	75.4	47
s4800992006060191	Prime Samm	74.0	29	74.2	82
s1920452008080594	Suffolk	73.0	71	73.7	92
s1900282007071494	Suffolk	72.2	91	73.5	96
s1912012008080094	Suffolk	72.1	94	73.2	107
s1900602008080369	Suffolk	71.5	114	72.8	110
s1901112007077058	Suffolk	71.4	115	72.8	111
s1918502001010120	Suffolk	71.4	116	71.9	129
s1913622007070027	Suffolk	70.9	121	71.8	130
s1920452007070508	Suffolk	70.9	123	71.8	131
s1900602007070267	Suffolk	70.6	131	71.7	134
s1916612008080491	Suffolk	70.0	144	70.6	148
s1704202007070224	Texel	68.8	161	70.4	154
s1700802007071532	Texel	68.7	165	69.7	161
s1700622007070144	Texel	68.3	173	69.4	165
s1700812008080039	Texel	68.2	175	69.0	171
s1702232004040080	Texel	67.7	177	67.5	178
s1702232007070046	Texel	67.6	178	67.4	179
s1704062007070028	Texel	67.0	183	67.1	180
s4702062007077118	White Dorper	74.2	22	77.2	11
s4701142007071345	White Dorper	73.3	59	76.3	26
s4700442008084825	White Dorper	73.2	65	75.3	51
s4701792008080386	White Dorper	72.9	74	75.1	59
s4700702003030011	White Dorper	72.2	92	74.6	72
s4701142006060036	White Dorper	72.0	97	73.4	102
s4701392006060057	White Dorper	70.4	137	72.6	114
s2301002007070677	White Suffolk	73.2	64	75.0	62
s2300262005050650	White Suffolk	71.6	109	73.1	108
s2301132007070040	White Suffolk	71.2	119	72.1	123
s2300262007072446	White Suffolk	70.9	124	71.9	124

s2301132008080205	White Suffolk	70.9	125	71.9	128
s2303182008080262	White Suffolk	70.8	127	71.7	133
s2304502007071456	White Suffolk	70.7	129	71.6	136
s2300012008080022	White Suffolk	70.6	133	71.5	138
s2300152009090255	White Suffolk	70.5	135	71.5	139
s2300022008080234	White Suffolk	70.3	138	71.2	141
s2300912007070008	White Suffolk	70.2	139	71.1	142
s2300992008080097	White Suffolk	70.1	140	71.1	143
s2303242008085244	White Suffolk	70.1	141	71.0	144
s2300262008083813	White Suffolk	70.1	142	70.8	145
s2300152007070143	White Suffolk	70.0	143	70.7	146
s2300432007070591	White Suffolk	70.0	145	70.6	147
s2303242007075630	White Suffolk	69.9	148	70.5	149
s2300022007070098	White Suffolk	69.9	149	70.5	150
s2300432008080644	White Suffolk	69.8	150	70.5	152
s2300302008080116	White Suffolk	69.8	152	70.5	153
s2300092007070279	White Suffolk	69.8	153	69.7	159
s2300342007074914	White Suffolk	69.3	156	69.6	162
s2300432008080136	White Suffolk	69.2	157	69.1	170

Table 11. The BLUP estimates for the sires within sire breed and their ranking for the Topside cut.

Sire Number	Breed	Tender	Rank Tender	Juicy	Rank Juicy
s0600032006060121	Bond	48.8	110	49.7	65
s0237802008080157	Border Leicester	56.1	7	56.0	2
s0244112006060369	Border Leicester	54.4	16	53.2	10
s020041200707J039	Border Leicester	52.4	43	51.9	20
s0236912008088370	Border Leicester	51.3	57	51.5	30

s0219292007070261	Border Leicester	51.0	67	51.4	31
s0246862007070179	Border Leicester	50.9	68	51.1	36
s0247152008080085	Border Leicester	50.8	69	50.7	44
s0236662006060976	Border Leicester	50.3	84	50.3	48
s0241662008080220	Border Leicester	49.9	91	49.3	78
s0250022008085029	Border Leicester	49.5	98	49.2	80
s1500622006060070	Coopworth	52.2	46	49.9	57
s1500292008080181	Coopworth	50.6	74	49.3	79
s1500392006061009	Coopworth	49.8	93	49.0	90
s1500292007070244	Coopworth	48.9	109	48.8	96
s1500992007071449	Coopworth	48.6	113	48.3	108
s1500152003030196	Coopworth	48.4	115	48.2	110
s1500482007070769	Coopworth	48.3	119	47.7	133
s1500482008080808	Coopworth	48.1	126	47.4	140
s0319232001011072	Corriedale	58.7	3	53.6	9
s0300362005050134	Corriedale	55.5	9	53.2	11
s0323612006060209	Corriedale	53.6	24	52.4	17
s0318972008080282	Corriedale	52.9	32	51.9	21
s0324012007070002	Corriedale	52.8	35	51.6	28
s0315272003030360	Corriedale	51.7	52	51.0	39
s0300182004045220	Corriedale	50.2	86	50.7	42
s0314602006543022	Corriedale	50.1	88	50.3	50
s0318972006060386	Corriedale	49.5	99	50.2	52
s0322722008080072	Corriedale	48.2	123	47.6	134
s5100492007071700	Dohne Merino	54.8	12	51.6	27
s5100072008084048	Dohne Merino	54.1	19	50.7	41
s5101402006060368	Dohne Merino	53.9	21	49.9	60
s5100072008083953	Dohne Merino	51.5	54	49.8	63
s5100732007070006	Dohne Merino	50.5	78	49.1	86
s5101462007070128	Dohne Merino	50.0	89	49.0	92
s5100092007070376	Dohne Merino	49.1	106	48.5	103
s5100292008088124	Dohne Merino	48.7	111	48.0	117
s5100032007070949	Dohne Merino	48.3	120	47.9	121
s5100302005050068	Dohne Merino	47.4	134	47.5	136
s4000302007071209	Dorper	52.7	38	54.1	6
s4000302007070056	Dorper	50.7	72	52.9	13
s4000302007070617	Dorper	49.7	96	51.8	24
s5000872006060096	Merino	56.6	5	52.3	18
s5037892007LB0753	Merino	55.8	8	51.9	22
s5047432000000503	Merino	55.4	10	51.3	33
s5007882007071254	Merino	54.3	18	51.2	34
s5034252006060205	Merino	53.7	22	51.2	35
s5038632006OL3626	Merino	53.3	28	51.0	37
s5030972005051737	Merino	53.2	30	51.0	38
s5018852006TRIMPH	Merino	52.8	34	50.8	40
s5015522006060480	Merino	52.7	37	50.7	43

s5044702006060022	Merino	52.6	39	50.2	54
s5030542004040585	Merino	52.5	40	49.8	62
s5030702008080121	Merino	52.4	42	49.7	64
s5007882008081290	Merino	52.0	48	49.7	66
s5049162007070719	Merino	52.0	49	49.6	68
s50505020080G0856	Merino	51.9	51	49.6	69
s5046152004040024	Merino	51.7	53	49.5	72
s5017042007L68007	Merino	51.4	55	49.4	76
s5035642007WHI393	Merino	51.2	60	49.3	77
s5039822006060225	Merino	51.2	62	49.1	88
s5000482007070260	Merino	51.2	64	49.0	91
s5022512006066030	Merino	50.7	71	48.8	97
s5023022006006580	Merino	50.7	73	48.4	105
s5043622006LON449	Merino	50.6	77	48.2	112
s5003182007070022	Merino	50.0	90	48.2	114
s5038842008081981	Merino	49.4	100	48.1	116
s5039462007OLY716	Merino	49.0	108	47.9	124
s5037892008080124	Merino	48.3	118	47.8	125
s5024252006023997	Merino	48.3	121	47.7	131
s5044822007070461	Merino	48.2	122	47.5	137
s50923420060C0573	Merino	47.9	128	47.5	139
s5049022005005345	Merino	47.3	135	47.2	143
s501587200606M276	Merino	47.2	137	47.1	145
s5044702008080588	Merino	47.0	140	45.9	163
s5049162008080600	Merino	44.9	164	45.4	170
s1622882007070644	Poll Dorset	49.4	101	50.4	47
s1637212007070311	Poll Dorset	47.9	129	48.4	104
s1611432008080203	Poll Dorset	46.3	149	48.3	109
s1619722006061831	Poll Dorset	45.9	153	47.8	127
s1600012008080010	Poll Dorset	45.9	154	47.3	141
s1636772008081037	Poll Dorset	45.5	156	47.1	144
s1640732007070364	Poll Dorset	45.4	157	46.9	147
s1640002009090052	Poll Dorset	45.4	158	46.8	148
s1618922006060050	Poll Dorset	45.1	161	46.6	152
s1612352007072025	Poll Dorset	45.1	162	46.2	158
s1627502008080481	Poll Dorset	44.6	167	46.0	161
s1612352008080608	Poll Dorset	44.6	168	45.7	165
s1629472008080219	Poll Dorset	44.5	169	45.6	166
s1611432007070025	Poll Dorset	44.2	172	45.6	167
s1603362008080541	Poll Dorset	43.5	175	45.6	168
s1622882008080077	Poll Dorset	43.5	176	45.3	171
s1619722009090133	Poll Dorset	43.0	177	45.1	174
s1618862008080157	Poll Dorset	42.8	178	44.6	177
s1611582007070190	Poll Dorset	42.6	179	44.5	178
s1614152007070440	Poll Dorset	41.1	180	44.3	180
s1601852007070369	Poll Dorset	40.4	181	43.2	181
s1623682007070468	Poll Dorset	40.2	182	43.1	182
s1600852008080021	Poll Dorset	39.1	183	43.0	183
s1636772007070839	Poll Dorset	39.0	184	41.4	184
s1635282007070182	Poll Dorset	39.0	185	40.7	185
s6013322004000WD 2	Poll Merino	59.5	1	54.7	3
s6010822007071257	Poll Merino	59.4	2	53.9	7

s6013562007000449	Poll Merino	56.5	6	51.9	19
s6012442007070304	Poll Merino	54.9	11	50.3	51
s6008152006060120	Poll Merino	53.0	31	50.2	53
s6008152007070323	Poll Merino	52.7	36	50.2	55
s6010532003031078	Poll Merino	52.5	41	50.0	56
s6011272007070121	Poll Merino	52.2	47	49.9	58
s6012792007070470	Poll Merino	51.3	58	49.9	59
s6013162007070023	Poll Merino	51.2	59	49.8	61
s6091542006060306	Poll Merino	51.2	63	49.4	73
s6004082007070069	Poll Merino	50.7	70	49.4	75
s6010822008081288	Poll Merino	50.6	75	49.1	85
s6008802006060627	Poll Merino	50.5	79	49.1	89
s6012502004407812	Poll Merino	50.5	80	48.9	94
s6013072005050165	Poll Merino	50.1	87	48.0	119
s6010532007071190	Poll Merino	49.8	94	47.9	122
s6013652006060052	Poll Merino	49.6	97	47.7	130
s6005712006060904	Poll Merino	49.2	105	47.0	146
s6013362008RAS004	Poll Merino	48.3	117	46.7	150
s6005712006060058	Poll Merino	47.7	131	46.5	154
s6005532007070002	Poll Merino	47.5	133	46.4	155
s6012882006063091	Poll Merino	47.1	139	46.1	159
s6090542006066533	Poll Merino	46.5	146	45.4	169
s6001052007071080	Poll Merino	46.3	148	45.2	173
s6091542004040062	Poll Merino	46.0	152	45.0	175
s6011272008088254	Poll Merino	44.4	170	44.4	179
s4800402008080217	Prime Samm	56.7	4	54.3	4
s4800392007070062	Prime Samm	54.6	14	53.6	8
s4800552007070068	Prime Samm	54.5	15	53.1	12
s4801222005051010	Prime Samm	54.0	20	52.8	15
s4801222008080343	Prime Samm	53.7	23	52.7	16
s4800872006060421	Prime Samm	53.6	25	51.8	25
s4800302008080078	Prime Samm	53.2	29	51.4	32
s4801042008080549	Prime Samm	52.8	33	50.5	45
s4800302008080111	Prime Samm	52.3	44	50.4	46
s4800992006060191	Prime Samm	49.0	107	50.3	49
s1900282007071494	Suffolk	53.4	27	51.5	29
s1901112007077058	Suffolk	52.2	45	49.6	67
s1920452008080594	Suffolk	50.4	82	49.5	70
s1912012008080094	Suffolk	50.3	83	49.5	71
s1913622007070027	Suffolk	49.8	92	49.1	87
s1918502001010120	Suffolk	49.3	103	48.7	98
s1900602008080369	Suffolk	48.7	112	48.5	101
s1916612008080491	Suffolk	48.1	124	48.5	102
s1900602007070267	Suffolk	48.0	127	47.8	128
s1920452007070508	Suffolk	46.7	143	47.8	129
s1700802007071532	Texel	48.4	116	49.2	82
s1700622007070144	Texel	47.1	138	48.8	95
s1704202007070224	Texel	46.9	142	48.2	111
s1700812008080039	Texel	46.3	147	48.2	115
s1704062007070028	Texel	45.6	155	47.3	142
s1702232007070046	Texel	45.1	160	46.8	149
s1702232004040080	Texel	44.0	173	45.3	172
s4702062007077118	White Dorper	54.7	13	56.1	1

s4700442008084825	White Dorper	54.4	17	54.2	5
s4701392006060057	White Dorper	53.5	26	52.8	14
s4701142007071345	White Dorper	51.9	50	51.8	23
s4700702003030011	White Dorper	51.2	61	51.7	26
s4701792008080386	White Dorper	51.1	65	49.2	81
s4701142006060036	White Dorper	47.6	132	49.1	84
s2301002007070677	White Suffolk	51.4	56	49.4	74
s2300262005050650	White Suffolk	51.0	66	49.2	83
s2300992008080097	White Suffolk	50.6	76	48.9	93
s2300012008080022	White Suffolk	50.4	81	48.6	99
s2304502007071456	White Suffolk	50.2	85	48.6	100
s2301132008080205	White Suffolk	49.8	95	48.3	106
s2303182008080262	White Suffolk	49.3	102	48.3	107
s2300302008080116	White Suffolk	49.2	104	48.2	113
s2300262007072446	White Suffolk	48.5	114	48.0	118
s2300152007070143	White Suffolk	48.1	125	48.0	120
s2300262008083813	White Suffolk	47.7	130	47.9	123
s2300912007070008	White Suffolk	47.2	136	47.8	126
s2301132007070040	White Suffolk	46.9	141	47.7	132
s2300152009090255	White Suffolk	46.6	144	47.6	135
s2303242008085244	White Suffolk	46.5	145	47.5	138
s2300432008080644	White Suffolk	46.0	150	46.7	151
s2300092007070279	White Suffolk	46.0	151	46.5	153
s2300342007074914	White Suffolk	45.3	159	46.3	156
s2300432008080136	White Suffolk	44.9	163	46.3	157
s2303242007075630	White Suffolk	44.6	165	46.0	160
s2300022008080234	White Suffolk	44.6	166	45.9	162
s2300432007070591	White Suffolk	44.2	171	45.8	164
s2300022007070098	White Suffolk	43.8	174	44.9	176

Sire Number	Breed	Flavour	Rank Flavour	Overall Liking	Rank Overall Liking
s0600032006060121	Bond	60.7	2	58.3	8
s020041200707J039	Border Leicester	61.3	1	59.9	1
s0244112006060369	Border Leicester	59.7	8	57.9	13
s0246862007070179	Border Leicester	58.1	30	55.7	37
s0236662006060976	Border Leicester	57.7	42	55.2	48
s0219292007070261	Border Leicester	57.5	45	55.1	54
s0237802008080157	Border Leicester	57.5	46	54.9	59
s0241662008080220	Border Leicester	57.5	47	54.7	63
s0250022008085029	Border Leicester	57.1	67	54.6	64
s0236912008088370	Border Leicester	56.4	88	54.2	72

s0247152008080085	Border Leicester	56.0	103	54.0	77
s1500292008080181	Coopworth	58.4	24	55.9	32
s1500392006061009	Coopworth	57.8	38	54.4	68
s1500622006060070	Coopworth	57.2	55	54.0	78
s1500292007070244	Coopworth	57.1	58	53.4	90
s1500992007071449	Coopworth	57.1	60	53.4	92
s1500152003030196	Coopworth	56.6	80	53.1	97
s1500482007070769	Coopworth	56.3	95	52.9	101
s1500482008080808	Coopworth	55.6	113	51.4	134
s0319232001011072	Corriedale	59.7	9	58.0	11
s0300362005050134	Corriedale	59.2	14	57.8	14
s0314602006543022	Corriedale	58.6	20	56.1	27
s0318972008080282	Corriedale	58.1	31	55.8	33
s0323612006060209	Corriedale	57.9	35	55.8	35
s0324012007070002	Corriedale	57.8	39	55.6	38
s0318972006060386	Corriedale	56.6	81	53.8	81
s0300182004045220	Corriedale	56.4	89	53.7	85
s0322722008080072	Corriedale	56.1	99	52.6	115
s0315272003030360	Corriedale	54.2	153	49.7	163
s5100072008084048	Dohne Merino	57.9	36	56.6	23
s5101462007070128	Dohne Merino	57.3	52	55.8	36
s5100072008083953	Dohne Merino	56.8	71	55.6	39
s5101402006060368	Dohne Merino	56.8	73	55.3	44
s5100092007070376	Dohne Merino	56.6	83	54.2	73
s5100032007070949	Dohne Merino	56.2	96	53.3	94
s5100292008088124	Dohne Merino	56.1	101	52.8	106
s5100732007070006	Dohne Merino	55.4	116	52.6	113
s5100492007071700	Dohne Merino	55.4	117	52.4	119
s5100302005050068	Dohne Merino	55.2	119	51.1	140
s4000302007071209	Dorper	59.3	12	58.3	7
s4000302007070056	Dorper	58.6	21	55.5	42
s4000302007070617	Dorper	57.9	34	54.8	60
s5000872006060096	Merino	58.6	22	57.2	17
s5015522006060480	Merino	58.3	28	56.3	24
s5007882007071254	Merino	58.2	29	56.1	26
s5035642007WHI393	Merino	57.9	32	56.1	28
s5030542004040585	Merino	57.8	37	56.0	31
s5003182007070022	Merino	57.4	48	55.5	41
s5034252006060205	Merino	57.2	56	55.3	46
s5037892007LB0753	Merino	57.2	57	55.2	49
s5047432000000503	Merino	57.1	62	55.1	50
s5018852006TRIMPH	Merino	57.1	63	55.1	53
s5030702008080121	Merino	57.1	64	55.1	56
s5022512006066030	Merino	57.1	66	55.0	57
s5044702006060022	Merino	56.8	70	54.7	62
s5030972005051737	Merino	56.7	77	54.6	65
s5000482007070260	Merino	56.7	78	54.1	74
s5007882008081290	Merino	56.7	79	54.0	76
s5049162007070719	Merino	56.5	85	54.0	79
s5038632006OL3626	Merino	56.5	86	53.7	87
s5023022006006580	Merino	56.3	90	53.5	89

s5039462007OLY716	Merino	56.3	91	53.4	91
s501587200606M276	Merino	56.3	93	52.9	102
s5017042007L68007	Merino	56.2	98	52.8	107
s5043622006LON449	Merino	56.1	100	52.7	109
s5046152004040024	Merino	55.7	109	52.5	117
s5039822006060225	Merino	55.6	112	52.0	126
s5038842008081981	Merino	55.2	123	51.8	129
s5049022005005345	Merino	55.1	127	51.7	130
s5037892008080124	Merino	54.8	137	51.6	131
s5044822007070461	Merino	54.6	140	51.4	135
s50923420060C0573	Merino	54.5	142	51.1	139
s50505020080G0856	Merino	54.5	144	50.8	145
s5049162008080600	Merino	54.4	150	49.8	160
s5024252006023997	Merino	54.3	152	49.6	165
s5044702008080588	Merino	53.5	163	47.8	177
s1622882007070644	Poll Dorset	55.2	122	52.9	100
s1619722006061831	Poll Dorset	55.0	129	52.7	111
s1637212007070311	Poll Dorset	55.0	131	52.2	121
s1640002009090052	Poll Dorset	54.6	141	52.2	122
s1611432008080203	Poll Dorset	54.5	147	51.9	128
s1627502008080481	Poll Dorset	53.8	160	51.4	136
s1611432007070025	Poll Dorset	53.4	164	51.1	141
s1622882008080077	Poll Dorset	53.3	167	50.6	149
s1612352008080608	Poll Dorset	53.1	168	50.4	154
s1618922006060050	Poll Dorset	53.0	169	50.0	157
s1600012008080010	Poll Dorset	53.0	170	49.8	158
s1640732007070364	Poll Dorset	52.9	171	49.7	164
s1611582007070190	Poll Dorset	52.9	172	49.6	166
s1629472008080219	Poll Dorset	52.8	173	49.6	167
s1636772008081037	Poll Dorset	52.8	174	49.4	168
s1603362008080541	Poll Dorset	52.8	175	49.2	172
s1619722009090133	Poll Dorset	52.6	177	49.0	174
s1614152007070440	Poll Dorset	52.5	178	47.7	178
s1618862008080157	Poll Dorset	51.6	179	47.6	179
s1612352007072025	Poll Dorset	51.1	180	46.7	180
s1601852007070369	Poll Dorset	51.0	181	46.5	181
s1623682007070468	Poll Dorset	50.8	182	46.2	182
s1600852008080021	Poll Dorset	50.4	183	46.1	183
s1636772007070839	Poll Dorset	50.2	184	45.2	184
s1635282007070182	Poll Dorset	49.1	185	43.6	185
s6008152006060120	Poll Merino	60.5	3	59.8	2
s6012442007070304	Poll Merino	60.2	4	59.0	4
s6013322004000WD 2	Poll Merino	59.9	5	58.2	9
s6010822007071257	Poll Merino	59.4	11	56.7	22
s6005712006060058	Poll Merino	58.9	16	56.1	25
s6010532007071190	Poll Merino	58.5	23	56.1	29
s6011272007070121	Poll Merino	58.4	25	56.0	30
s6013162007070023	Poll Merino	57.7	41	55.8	34
s6004082007070069	Poll Merino	57.6	43	55.3	47
s6013562007000449	Poll Merino	57.4	49	55.1	51
s6010532003031078	Poll Merino	57.4	50	54.7	61
s6001052007071080	Poll Merino	57.2	54	54.5	66

s6090542006066533	Poll Merino	57.1	61	54.3	70
s6008802006060627	Poll Merino	57.1	65	54.3	71
s6091542006060306	Poll Merino	56.9	69	54.1	75
s6005712006060904	Poll Merino	56.6	82	53.8	82
s6008152007070323	Poll Merino	56.3	92	53.7	86
s6012792007070470	Poll Merino	56.0	102	53.1	99
s6012502004407812	Poll Merino	55.5	115	52.9	103
s6005532007070002	Poll Merino	55.2	121	51.6	132
s6013072005050165	Poll Merino	55.1	128	51.5	133
s6010822008081288	Poll Merino	55.0	130	51.0	142
s6013362008RAS004	Poll Merino	54.9	134	50.7	147
s6011272008088254	Poll Merino	54.4	149	50.6	148
s6091542004040062	Poll Merino	54.1	157	49.8	159
s6012882006063091	Poll Merino	53.4	165	49.4	170
s6013652006060052	Poll Merino	52.6	176	49.0	175
s4801222005051010	Prime Samm	59.9	6	59.0	5
s4800402008080217	Prime Samm	59.2	13	58.1	10
s4800302008080111	Prime Samm	59.1	15	57.9	12
s4800552007070068	Prime Samm	58.9	17	57.4	15
s4801222008080343	Prime Samm	58.8	19	57.4	16
s4800392007070062	Prime Samm	58.3	26	57.2	18
s4800302008080078	Prime Samm	57.9	33	55.4	43
s4801042008080549	Prime Samm	57.6	44	55.1	52
s4800872006060421	Prime Samm	56.8	74	55.0	58
s4800992006060191	Prime Samm	56.7	76	54.3	69
s1920452008080594	Suffolk	58.3	27	57.1	19
s1900282007071494	Suffolk	57.4	51	55.1	55
s1912012008080094	Suffolk	57.3	53	54.5	67
s1900602008080369	Suffolk	56.7	75	53.8	80
s1901112007077058	Suffolk	56.4	87	53.8	83
s1918502001010120	Suffolk	56.3	94	53.2	96
s1913622007070027	Suffolk	56.0	104	52.7	112
s1920452007070508	Suffolk	55.9	108	52.1	124
s1900602007070267	Suffolk	54.9	132	52.1	125
s1916612008080491	Suffolk	54.5	145	50.9	144
s1704202007070224	Texel	56.8	72	53.3	95
s1700802007071532	Texel	55.6	110	52.4	118
s1700622007070144	Texel	55.1	126	52.3	120
s1700812008080039	Texel	54.8	136	50.7	146
s1702232004040080	Texel	54.7	138	50.5	151
s1702232007070046	Texel	54.3	151	50.5	152
s1704062007070028	Texel	54.1	155	49.7	162
s4702062007077118	White Dorper	59.7	7	59.2	3
s4701142007071345	White Dorper	59.6	10	58.8	6
s4700442008084825	White Dorper	58.8	18	57.0	20
s4701792008080386	White Dorper	57.7	40	57.0	21
s4700702003030011	White Dorper	57.1	59	55.3	45
s4701142006060036	White Dorper	56.0	105	53.6	88
s4701392006060057	White Dorper	55.2	124	53.3	93
s2301002007070677	White Suffolk	57.0	68	55.5	40
s2300262005050650	White Suffolk	56.6	84	53.7	84
s2301132007070040	White Suffolk	56.2	97	53.1	98
s2300262007072446	White Suffolk	56.0	106	52.8	104

s2301132008080205	White Suffolk	55.9	107	52.8	105
s2303182008080262	White Suffolk	55.6	111	52.7	108
s2304502007071456	White Suffolk	55.5	114	52.7	110
s2300012008080022	White Suffolk	55.3	118	52.6	114
s2300152009090255	White Suffolk	55.2	120	52.6	116
s2300022008080234	White Suffolk	55.1	125	52.2	123
s2300912007070008	White Suffolk	54.9	133	52.0	127
s2300992008080097	White Suffolk	54.8	135	51.2	137
s2303242008085244	White Suffolk	54.6	139	51.2	138
s2300262008083813	White Suffolk	54.5	143	51.0	143
s2300152007070143	White Suffolk	54.5	146	50.6	150
s2300432007070591	White Suffolk	54.4	148	50.4	153
s2303242007075630	White Suffolk	54.1	154	50.3	155
s2300022007070098	White Suffolk	54.1	156	50.2	156
s2300432008080644	White Suffolk	54.0	158	49.8	161
s2300302008080116	White Suffolk	54.0	159	49.4	169
s2300092007070279	White Suffolk	53.7	161	49.3	171
s2300342007074914	White Suffolk	53.7	162	49.2	173
s2300432008080136	White Suffolk	53.3	166	48.4	176

Table 12.5. The correlations between the sire ranks for the sensory variables for both the loin and the topside cuts.

	Loin tender	Loin juicy	Loin flavour	Loin overall liking	Topside tender	Topside juicy	Topside flavour	Topside overall liking
Loin tender		0.97	0.96	0.98	0.93	0.83	0.86	0.86
Loin juicy			0.97	0.99	0.88	0.77	0.81	0.82
Loin flavour				0.98	0.87	0.74	0.78	0.79
Loin overall liking					0.90	0.79	0.82	0.84
Topside tender						0.93	0.94	0.95
Topside juicy							0.95	0.96
Topside Flavour								0.98
Topside overall liking								

Table 13.5 The variance components for the logit analysis of star classifications 2 an3 verses star classifications 4 and 5 and for the logit analysis of star classification 4 verses star classification 5 for the loin and topside cuts. Estimates with IMF and SHEARF5 in the model are in brackets.

Random Effect	Loin		Topside	
	Stars 2,3 v Stars 4,5	Star 4 v Star 5	Stars 2,3 v Stars 4,5	Star 4 v Star 5
Consumer within Pick	0.82 (0.88)	0.45	1.35 (0.63)	0.50
Pick	0.04 (0.04)	0.02	0.02 (0.03)	0.0
Sire with sire breed within Kill group:	0.13 (0.06)	0.0	0.17 (0.16)	0.0
Kill group	0.01 (0.07)	0.01	0.0 (0.03)	0.0
Residual				

Table 14.5. The Logit estimates for the year effect for star classifications 2 and 3 v star classification 4 and 5, and star classification 4 v star classification 5

Star 2 and 3 v star 4 and 5

Year	2009		2010	
	Logit	Probability in star 4 or 5	Logit	Probability in star 4 or 5
Loin	0.82** ± 0.09	69%	0.48 ± 0.08	62%
Topside	-0.74*** ± 0.06	32%	-1.29 ± 0.06	22%

Table 15.5. The logits and standard errors for the sire breed for star classifications 2 and 3 v star classification 4 and 5, and star classification 4 v star classification 5

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Sire breed	Star 2, 3 v Star 4,5				Star 4 v Star 5			
	Loin		Topside		Loin		Topside	
	Logit	Prop in Star 4, 5	Logit	Prop in Star 4, 5	Logit	Prop in Star 5	Logit	Prop in Star 5
Bond	1.10 ± 0.39	75	-0.80 ± 0.39	31	-0.34 ± 0.37	42	-1.21 ± 0.63	23
Border Leicester	0.68 ± 0.12	66	-0.90 ± 0.13	29	-0.45 ±0.12	39	-1.23 ± 0.22	23
Coopworth	0.57 ± 0.12	64	-1.14 ± 0.14	24	-0.50 ± 0.13	38	-1.03 ± 0.23	26
Corriedale	0.78 ± 0.12	69	-0.89 ± 0.13	29	-0.39 ± 0.12	40	-1.36 ± 0.22	20
Dohne Merino	0.79 ± 0.11	69	-1.10 ± 0.12	25	-0.42 ± 0.11	40	-1.17 ± 0.20	24
Dorper	0.57 ± 0.23	64	-0.76 ± 0.25	32	-0.45 ± 0.20	39	-0.95 ± 0.34	28
Merino	0.92 ± 0.10	72	-1.20 ± 0.11	23	-0.44 ± 0.10	39	-1.58 ± 0.20	17
Poll Dorset	0.10 ± 0.08	52	-1.41 ± 0.09	20	-0.63 ± 0.08	35	-1.36 ± 0.16	20
Poll Merino	0.66 ± 0.11	66	-1.15 ± 0.11	24	-0.37 ± 0.11	41	-1.18 ± 0.19	24
Prime Samm	0.98 ± 0.11	73	-0.82 ± 0.11	31	-0.12 ± 0.10	47	-1.59 ± 0.20	17
Suffolk	0.52 ± 0.12	63	-1.09 ± 0.13	25	-0.47 ± 0.12	38	-1.36 ± 0.23	20
Texel	0.16 ± 0.12	54	-1.12 ± 0.14	25	-0.63 ± 0.14	35	-1.53 ± 0.24	18
White Dorper	0.95 ± 0.17	72	-0.75 ± 0.16	32	-0.30 ± 0.14	43	-1.23 ± 0.23	23
White Suffolk	0.32 ± 0.09	58	-1.06 ± 0.09	26	-0.64 ± 0.09	35	-1.46 ± 0.16	19

Table 16.5. The significant ($P < 0.05$) sire breed comparisons for the Loin cut for star classifications 2 and 3 *verses* star classifications 4 and 5

Sire Breed Comparison			Difference in estimates	Significance
Poll Dorset	v	Merino	-0.65	0.01
Poll Dorset	v	Prime Samm	-0.67	0.01
Poll Dorset	v	Dohne Merino	-0.58	0.02
Poll Dorset	v	White Dorper	-0.80	0.04
Texel	v	Prime Samm	-0.64	0.05

Table 17.5. The sire BLUP estimates for the logit analysis of star classifications 2 and 3 *verses* star classifications 4 and 5 for the loin cut

Sire	Breed	Logit stars 2,3 v stars 4,5	Rank stars 2,3 v stars 4,5	Probability of being in star 4,5†
ss0600032006060121	Bond	0.73	37	0.67
ss0237802008080157	Border Leicester	0.73	40	0.67
ss0236912008088370	Border Leicester	0.73	41	0.67
s020041200707J039	Border Leicester	0.68	65	0.66
ss0241662008080220	Border Leicester	0.66	73	0.66
ss0219292007070261	Border Leicester	0.65	75	0.66
ss0236662006060976	Border Leicester	0.63	87	0.65
ss0244112006060369	Border Leicester	0.62	98	0.65
ss0246862007070179	Border Leicester	0.57	123	0.64
ss0250022008085029	Border Leicester	0.54	131	0.63
ss0247152008080085	Border Leicester	0.54	133	0.63
ss1500622006060070	Coopworth	0.72	46	0.67
ss1500292007070244	Coopworth	0.70	54	0.67
ss1500992007071449	Coopworth	0.67	70	0.66
ss1500292008080181	Coopworth	0.63	90	0.65
ss1500482007070769	Coopworth	0.62	92	0.65
ss1500392006061009	Coopworth	0.61	105	0.65
ss1500482008080808	Coopworth	0.53	135	0.63
ss1500152003030196	Coopworth	0.50	154	0.62
ss0300362005050134	Corriedale	0.82	9	0.69
ss0318972008080282	Corriedale	0.78	17	0.69
ss0319232001011072	Corriedale	0.74	33	0.68
ss0318972006060386	Corriedale	0.72	45	0.67
ss0323612006060209	Corriedale	0.67	71	0.66
ss0314602006543022	Corriedale	0.66	72	0.66
ss0324012007070002	Corriedale	0.59	116	0.64
ss0300182004045220	Corriedale	0.57	124	0.64
ss0315272003030360	Corriedale	0.50	155	0.62
ss0322722008080072	Corriedale	0.44	175	0.61
ss5100092007070376	Dohne Merino	0.81	10	0.69
ss5100492007071700	Dohne Merino	0.75	31	0.68
ss5100072008084048	Dohne Merino	0.70	52	0.67
ss5100732007070006	Dohne Merino	0.70	55	0.67
ss5100032007070949	Dohne Merino	0.67	68	0.66
ss5101402006060368	Dohne Merino	0.67	69	0.66
ss5101462007070128	Dohne Merino	0.65	77	0.66
ss5100072008083953	Dohne Merino	0.61	104	0.65
ss5100302005050068	Dohne Merino	0.56	128	0.64
ss5100292008088124	Dohne Merino	0.53	136	0.63
ss4000302007070056	Dorper	0.72	44	0.67
ss4000302007070617	Dorper	0.71	51	0.67
ss4000302007071209	Dorper	0.42	177	0.60
ss5034252006060205	Merino	1.03	1	0.74
ss5007882008081290	Merino	0.93	3	0.72
ss5037892008080124	Merino	0.84	7	0.70
ss5049162007070719	Merino	0.80	12	0.69

ss5044822007070461	Merino	0.79	15	0.69
ss5049022005005345	Merino	0.78	18	0.69
ss5007882007071254	Merino	0.77	19	0.68
ss5015522006060480	Merino	0.77	20	0.68
ss50923420060C0573	Merino	0.76	26	0.68
ss5023022006006580	Merino	0.76	28	0.68
ss5000482007070260	Merino	0.75	32	0.68
ss5044702006060022	Merino	0.74	34	0.68
ss5037892007LB0753	Merino	0.73	38	0.67
ss5038842008081981	Merino	0.73	42	0.67
ss5039462007OLY716	Merino	0.71	48	0.67
ss501587200606M276	Merino	0.71	50	0.67
ss5030702008080121	Merino	0.70	58	0.67
ss5043622006LON449	Merino	0.69	60	0.67
ss5022512006066030	Merino	0.69	61	0.67
ss5047432000000503	Merino	0.68	64	0.66
ss5046152004040024	Merino	0.68	66	0.66
ss5030542004040585	Merino	0.67	67	0.66
ss5038632006OL3626	Merino	0.66	74	0.66
ss50505020080G0856	Merino	0.64	80	0.65
ss5035642007WHI393	Merino	0.63	89	0.65
ss5018852006TRIMPH	Merino	0.62	91	0.65
ss5039822006060225	Merino	0.62	95	0.65
ss5024252006023997	Merino	0.62	96	0.65
ss5044702008080588	Merino	0.61	107	0.65
ss5030972005051737	Merino	0.60	110	0.65
ss5017042007L68007	Merino	0.53	137	0.63
ss5003182007070022	Merino	0.48	163	0.62
ss5000872006060096	Merino	0.48	164	0.62
ss5049162008080600	Merino	0.46	170	0.61
ss1622882008080077	Poll Dorset	0.85	5	0.70
ss1629472008080219	Poll Dorset	0.76	22	0.68
ss1637212007070311	Poll Dorset	0.72	43	0.67
ss1635282007070182	Poll Dorset	0.70	56	0.67
ss1601852007070369	Poll Dorset	0.69	62	0.67
ss1612352007072025	Poll Dorset	0.62	93	0.65
ss1640732007070364	Poll Dorset	0.61	102	0.65
ss1619722009090133	Poll Dorset	0.59	118	0.64
ss1619722006061831	Poll Dorset	0.58	120	0.64
ss1600012008080010	Poll Dorset	0.56	126	0.64
ss1600852008080021	Poll Dorset	0.51	145	0.62
ss1603362008080541	Poll Dorset	0.51	148	0.62
ss1611432008080203	Poll Dorset	0.50	150	0.62
ss1640002009090052	Poll Dorset	0.49	157	0.62
ss1614152007070440	Poll Dorset	0.49	158	0.62
ss1611582007070190	Poll Dorset	0.49	160	0.62
ss1627502008080481	Poll Dorset	0.49	161	0.62
ss1618922006060050	Poll Dorset	0.46	169	0.61
ss1636772008081037	Poll Dorset	0.45	173	0.61
ss1623682007070468	Poll Dorset	0.40	179	0.60
ss1636772007070839	Poll Dorset	0.39	180	0.60
ss1612352008080608	Poll Dorset	0.38	181	0.59
ss1622882007070644	Poll Dorset	0.37	182	0.59

ss1611432007070025	Poll Dorset	0.34	184	0.58
ss1618862008080157	Poll Dorset	0.27	185	0.57
ss6010822007071257	Poll Merino	0.89	4	0.71
ss6013322004000WD2	Poll Merino	0.83	8	0.70
ss6091542004040062	Poll Merino	0.76	25	0.68
ss6008152007070323	Poll Merino	0.76	27	0.68
ss6005532007070002	Poll Merino	0.74	35	0.68
ss6012442007070304	Poll Merino	0.73	36	0.67
ss6013072005050165	Poll Merino	0.73	39	0.67
ss6005712006060904	Poll Merino	0.72	47	0.67
ss6012502004407812	Poll Merino	0.71	49	0.67
ss6008802006060627	Poll Merino	0.65	76	0.66
ss6008152006060120	Poll Merino	0.64	83	0.65
ss6013562007000449	Poll Merino	0.63	85	0.65
ss6013652006060052	Poll Merino	0.63	86	0.65
ss6013162007070023	Poll Merino	0.62	94	0.65
ss6012882006063091	Poll Merino	0.62	97	0.65
ss6011272007070121	Poll Merino	0.62	100	0.65
ss6010532007071190	Poll Merino	0.61	103	0.65
ss6011272008088254	Poll Merino	0.60	111	0.65
ss6001052007071080	Poll Merino	0.58	119	0.64
ss6012792007070470	Poll Merino	0.57	121	0.64
ss6091542006060306	Poll Merino	0.53	139	0.63
ss6013362008RAS004	Poll Merino	0.51	146	0.62
ss6005712006060058	Poll Merino	0.50	151	0.62
ss6010532003031078	Poll Merino	0.49	159	0.62
ss6090542006066533	Poll Merino	0.47	167	0.62
ss6004082007070069	Poll Merino	0.44	174	0.61
ss6010822008081288	Poll Merino	0.36	183	0.59
ss4801222005051010	Prime Samm	0.80	14	0.69
ss4800302008080078	Prime Samm	0.79	16	0.69
ss4800402008080217	Prime Samm	0.76	23	0.68
ss4800872006060421	Prime Samm	0.75	29	0.68
ss4800552007070068	Prime Samm	0.70	53	0.67
ss4801222008080343	Prime Samm	0.64	78	0.65
ss4800392007070062	Prime Samm	0.62	99	0.65
ss4801042008080549	Prime Samm	0.60	109	0.65
ss4800992006060191	Prime Samm	0.60	113	0.65
ss4800302008080111	Prime Samm	0.47	165	0.62
ss1901112007077058	Suffolk	0.76	24	0.68
ss1900602008080369	Suffolk	0.70	57	0.67
ss1912012008080094	Suffolk	0.64	81	0.65
ss1918502001010120	Suffolk	0.61	106	0.65
ss1900602007070267	Suffolk	0.59	114	0.64
ss1916612008080491	Suffolk	0.59	115	0.64
ss1900282007071494	Suffolk	0.59	117	0.64
ss1920452008080594	Suffolk	0.54	132	0.63
ss1913622007070027	Suffolk	0.51	149	0.62
ss1920452007070508	Suffolk	0.50	152	0.62
ss1700622007070144	Texel	0.64	82	0.65
ss1704202007070224	Texel	0.64	84	0.65
ss1704062007070028	Texel	0.52	143	0.63
ss1702232007070046	Texel	0.46	171	0.61

ss1700802007071532	Texel	0.45	172	0.61
ss1702232004040080	Texel	0.42	176	0.60
ss1700812008080039	Texel	0.42	178	0.60
ss4701392006060057	White Dorper	0.95	2	0.72
ss4701142007071345	White Dorper	0.81	11	0.69
ss4702062007077118	White Dorper	0.77	21	0.68
ss4701792008080386	White Dorper	0.75	30	0.68
ss4700702003030011	White Dorper	0.69	63	0.67
ss4701142006060036	White Dorper	0.50	153	0.62
ss4700442008084825	White Dorper	0.48	162	0.62
ss2300342007074914	White Suffolk	0.84	6	0.70
ss2300302008080116	White Suffolk	0.80	13	0.69
ss2300022007070098	White Suffolk	0.69	59	0.67
ss2300262005050650	White Suffolk	0.64	79	0.65
ss2301002007070677	White Suffolk	0.63	88	0.65
ss2300262007072446	White Suffolk	0.61	101	0.65
ss2301132008080205	White Suffolk	0.60	108	0.65
ss2300262008083813	White Suffolk	0.60	112	0.65
ss2300092007070279	White Suffolk	0.57	122	0.64
ss2303242008085244	White Suffolk	0.56	125	0.64
ss2300012008080022	White Suffolk	0.56	127	0.64
ss2300912007070008	White Suffolk	0.55	129	0.63
ss2300992008080097	White Suffolk	0.54	130	0.63
ss2300022008080234	White Suffolk	0.54	134	0.63
ss2300152009090255	White Suffolk	0.53	138	0.63
ss2301132007070040	White Suffolk	0.52	140	0.63
ss2300152007070143	White Suffolk	0.52	141	0.63
ss2300432007070591	White Suffolk	0.52	142	0.63
ss2304502007071456	White Suffolk	0.52	144	0.63
ss2303242007075630	White Suffolk	0.51	147	0.62
ss2300432008080644	White Suffolk	0.50	156	0.62
ss2303182008080262	White Suffolk	0.47	166	0.62
ss2300432008080136	White Suffolk	0.46	168	0.61

† Corrected for sire breed effects

Table 18.5. The sire BLUP estimates for the logit analysis of star classifications 2 and 3 *verses* star classifications 4 and 5 for the topside cut

Sire	Breed	Logit stars 2,3 v stars 4,5	Rank 2,3 v stars 4,5	Probability of being in stars 4, 5†
s0600032006060121	Bond	0.31	64	0.58

s0244112006060369	Border Leicester	0.52	8	0.63
s020041200707J039	Border Leicester	0.43	21	0.61
s0237802008080157	Border Leicester	0.42	22	0.60
s0241662008080220	Border Leicester	0.39	29	0.60
s0246862007070179	Border Leicester	0.35	45	0.59
s0250022008085029	Border Leicester	0.30	71	0.57
s0219292007070261	Border Leicester	0.30	75	0.57
s0236912008088370	Border Leicester	0.24	105	0.56
s0247152008080085	Border Leicester	0.22	113	0.55
s0236662006060976	Border Leicester	0.13	163	0.53
s1500292007070244	Coopworth	0.46	16	0.61
s1500482008080808	Coopworth	0.39	31	0.60
s1500992007071449	Coopworth	0.34	51	0.58
s1500152003030196	Coopworth	0.32	63	0.58
s1500482007070769	Coopworth	0.19	130	0.55
s1500292008080181	Coopworth	0.18	133	0.54
s1500622006060070	Coopworth	0.16	149	0.54
s1500392006061009	Coopworth	0.05	180	0.51
s0315272003030360	Corriedale	0.67	1	0.66
s0300362005050134	Corriedale	0.63	2	0.65
s0323612006060209	Corriedale	0.40	27	0.60
s0318972008080282	Corriedale	0.35	46	0.59
s0319232001011072	Corriedale	0.30	73	0.57
s0314602006543022	Corriedale	0.25	101	0.56
s0300182004045220	Corriedale	0.23	110	0.56
s0324012007070002	Corriedale	0.20	123	0.55
s0318972006060386	Corriedale	0.18	135	0.54
s0322722008080072	Corriedale	0.15	155	0.54
s5100492007071700	Dohne Merino	0.38	33	0.59
s5100072008084048	Dohne Merino	0.37	36	0.59
s5100092007070376	Dohne Merino	0.35	47	0.59
s5101402006060368	Dohne Merino	0.35	48	0.59
s5100072008083953	Dohne Merino	0.32	60	0.58
s5100032007070949	Dohne Merino	0.23	108	0.56
s5100292008088124	Dohne Merino	0.20	121	0.55
s5100302005050068	Dohne Merino	0.20	126	0.55
s5100732007070006	Dohne Merino	0.16	146	0.54
s5101462007070128	Dohne Merino	0.14	157	0.53
s4000302007071209	Dorper	0.57	5	0.64
s4000302007070617	Dorper	0.33	53	0.58
s4000302007070056	Dorper	0.32	56	0.58
s5007882008081290	Merino	0.62	3	0.65
s5018852006TRIMPH	Merino	0.57	4	0.64

s501587200606M276	Merino	0.50	10	0.62
s5015522006060480	Merino	0.45	17	0.61
s5037892008080124	Merino	0.37	35	0.59
s5038632006OL3626	Merino	0.37	37	0.59
s5039822006060225	Merino	0.34	52	0.58
s50923420060C0573	Merino	0.32	61	0.58
s5037892007LB0753	Merino	0.31	65	0.58
s5044702006060022	Merino	0.30	72	0.57
s5000872006060096	Merino	0.29	82	0.57
s5000482007070260	Merino	0.26	94	0.56
s5007882007071254	Merino	0.26	96	0.56
s5047432000000503	Merino	0.26	97	0.56
s5049162007070719	Merino	0.25	100	0.56
s5038842008081981	Merino	0.23	106	0.56
s5039462007OLY716	Merino	0.23	107	0.56
s5030702008080121	Merino	0.22	117	0.55
s5049022005005345	Merino	0.20	122	0.55
s5024252006023997	Merino	0.18	134	0.54
s5030542004040585	Merino	0.17	137	0.54
s5043622006LON449	Merino	0.17	139	0.54
s5049162008080600	Merino	0.17	140	0.54
s5023022006006580	Merino	0.16	145	0.54
s5035642007WHI393	Merino	0.15	153	0.54
s5017042007L68007	Merino	0.14	161	0.53
s50505020080G0856	Merino	0.12	165	0.53
s5034252006060205	Merino	0.11	167	0.53
s5044702008080588	Merino	0.10	169	0.52
s5022512006066030	Merino	0.09	172	0.52
s5044822007070461	Merino	0.08	174	0.52
s5003182007070022	Merino	0.06	177	0.51
s5030972005051737	Merino	0.05	179	0.51
s5046152004040024	Merino	-0.04	185	0.49
s1623682007070468	Poll Dorset	0.36	39	0.59
s1622882008080077	Poll Dorset	0.35	44	0.59
s1611432008080203	Poll Dorset	0.33	55	0.58
s1635282007070182	Poll Dorset	0.31	67	0.58
s1637212007070311	Poll Dorset	0.30	70	0.57
s1619722009090133	Poll Dorset	0.30	74	0.57
s1611582007070190	Poll Dorset	0.29	79	0.57
s1640732007070364	Poll Dorset	0.29	83	0.57
s1619722006061831	Poll Dorset	0.27	87	0.57
s1618862008080157	Poll Dorset	0.26	95	0.56
s1603362008080541	Poll Dorset	0.25	102	0.56
s1601852007070369	Poll Dorset	0.24	103	0.56
s1640002009090052	Poll Dorset	0.23	109	0.56
s1611432007070025	Poll Dorset	0.23	111	0.56
s1612352008080608	Poll Dorset	0.19	128	0.55
s1600012008080010	Poll Dorset	0.19	129	0.55
s1627502008080481	Poll Dorset	0.17	141	0.54
s1614152007070440	Poll Dorset	0.16	144	0.54
s1636772007070839	Poll Dorset	0.15	150	0.54
s1629472008080219	Poll Dorset	0.15	154	0.54
s1636772008081037	Poll Dorset	0.14	160	0.53

s1622882007070644	Poll Dorset	0.12	166	0.53
s1612352007072025	Poll Dorset	0.11	168	0.53
s1618922006060050	Poll Dorset	0.10	171	0.52
s1600852008080021	Poll Dorset	0.08	175	0.52
s6013072005050165	Poll Merino	0.52	6	0.63
s6008152006060120	Poll Merino	0.52	7	0.63
s6013322004000WD2	Poll Merino	0.49	11	0.62
s6010532007071190	Poll Merino	0.47	14	0.62
s6010822008081288	Poll Merino	0.39	28	0.60
s6005532007070002	Poll Merino	0.35	50	0.59
s6004082007070069	Poll Merino	0.30	69	0.57
s6013162007070023	Poll Merino	0.29	76	0.57
s6013362008RAS004	Poll Merino	0.29	80	0.57
s6005712006060058	Poll Merino	0.28	85	0.57
s6010532003031078	Poll Merino	0.27	90	0.57
s6012442007070304	Poll Merino	0.27	91	0.57
s6013562007000449	Poll Merino	0.26	93	0.56
s6005712006060904	Poll Merino	0.26	98	0.56
s6008152007070323	Poll Merino	0.24	104	0.56
s6012882006063091	Poll Merino	0.22	116	0.55
s6012502004407812	Poll Merino	0.20	124	0.55
s6011272008088254	Poll Merino	0.20	125	0.55
s6091542006060306	Poll Merino	0.18	131	0.54
s6090542006066533	Poll Merino	0.16	147	0.54
s6012792007070470	Poll Merino	0.16	148	0.54
s6011272007070121	Poll Merino	0.15	156	0.54
s6008802006060627	Poll Merino	0.12	164	0.53
s6013652006060052	Poll Merino	0.09	173	0.52
s6091542004040062	Poll Merino	0.07	176	0.52
s6010822007071257	Poll Merino	0.03	182	0.51
s6001052007071080	Poll Merino	-0.02	184	0.50
s4800402008080217	Prime Samm	0.48	13	0.62
s4801222005051010	Prime Samm	0.47	15	0.62
s4801222008080343	Prime Samm	0.39	30	0.60
s4800872006060421	Prime Samm	0.36	38	0.59
s4800552007070068	Prime Samm	0.35	49	0.59
s4800302008080078	Prime Samm	0.31	66	0.58
s4800392007070062	Prime Samm	0.27	88	0.57
s4801042008080549	Prime Samm	0.26	99	0.56
s4800992006060191	Prime Samm	0.15	151	0.54
s4800302008080111	Prime Samm	0.14	162	0.53
s1900602007070267	Suffolk	0.43	19	0.61
s1920452008080594	Suffolk	0.36	40	0.59
s1900602008080369	Suffolk	0.36	42	0.59
s1918502001010120	Suffolk	0.35	43	0.59
s1901112007077058	Suffolk	0.32	58	0.58
s1912012008080094	Suffolk	0.29	81	0.57
s1916612008080491	Suffolk	0.28	86	0.57
s1913622007070027	Suffolk	0.18	136	0.54
s1920452007070508	Suffolk	0.06	178	0.51
s1900282007071494	Suffolk	0.05	181	0.51
s1700802007071532	Texel	0.40	24	0.60
s1700622007070144	Texel	0.40	25	0.60

s1702232007070046	Texel	0.29	77	0.57
s1704202007070224	Texel	0.22	115	0.55
s1700812008080039	Texel	0.19	127	0.55
s1704062007070028	Texel	0.14	159	0.53
s1702232004040080	Texel	0.10	170	0.52
s4700442008084825	White Dorper	0.50	9	0.62
s4700702003030011	White Dorper	0.49	12	0.62
s4701142007071345	White Dorper	0.43	20	0.61
s4701792008080386	White Dorper	0.38	32	0.59
s4701392006060057	White Dorper	0.29	84	0.57
s4702062007077118	White Dorper	0.26	92	0.56
s4701142006060036	White Dorper	0.00	183	0.50
s2300152007070143	White Suffolk	0.43	18	0.61
s2300022007070098	White Suffolk	0.41	23	0.60
s2304502007071456	White Suffolk	0.40	26	0.60
s2300302008080116	White Suffolk	0.37	34	0.59
s2300262005050650	White Suffolk	0.36	41	0.59
s2301132007070040	White Suffolk	0.33	54	0.58
s2300342007074914	White Suffolk	0.32	57	0.58
s2300432007070591	White Suffolk	0.32	59	0.58
s2303242008085244	White Suffolk	0.32	62	0.58
s2303182008080262	White Suffolk	0.30	68	0.57
s2300092007070279	White Suffolk	0.29	78	0.57
s2300262007072446	White Suffolk	0.27	89	0.57
s2300152009090255	White Suffolk	0.23	112	0.56
s2300992008080097	White Suffolk	0.22	114	0.55
s2300022008080234	White Suffolk	0.21	118	0.55
s2300262008083813	White Suffolk	0.21	119	0.55
s2300012008080022	White Suffolk	0.21	120	0.55
s2303242007075630	White Suffolk	0.18	132	0.54
s2301002007070677	White Suffolk	0.17	138	0.54
s2301132008080205	White Suffolk	0.17	142	0.54
s2300912007070008	White Suffolk	0.16	143	0.54
s2300432008080644	White Suffolk	0.15	152	0.54
s2300432008080136	White Suffolk	0.14	158	0.53

† Corrected for sire breed effects

Table 19.5. The number and percentages of samples correctly and incorrectly allocated to a star classification using the optimal discriminant functions for the loin and topside cuts

Loin cut numbers correctly and incorrectly classified

Star Rating	Estimate 2	Estimate 3	Estimate 4	Estimate 5
Actual 2	450	277	4	1
Actual 3	233	2797	934	82
Actual 4	6	760	2411	609
Actual 5	2	34	847	1659

Loin percentages correctly and incorrectly classified

Star Rating	Estimate 2	Estimate 3	Estimate 4	Estimate 5
Actual 2	65	7	1	-
Actual 3	34	72	22	3
Actual 4	1	20	57	26
Actual 5	-	1	20	71

Topside cut numbers correctly and incorrectly classified

Star Rating	Estimate 2	Estimate 3	Estimate 4	Estimate 5
Actual 2	2629	834	4	0
Actual 3	633	4460	398	1
Actual 4	3	793	790	8
Actual 5	2	44	394	51

Topside percentages correctly and incorrectly classified

Star Rating	Estimate 2	Estimate 3	Estimate 4	Estimate 5
Actual 2	80	14	-	0
Actual 3	19	73	25	2
Actual 4	1	12	50	13
Actual 5	-	1	25	85

Table 20.5. Multinomial logit estimates for calculating the probability of a meat sample with particular values of tenderness, juiciness, flavour and the residual on overall liking of being in one of the star classifications 2, 3, 4 or 5. The reference is star 2.

Loin

Star rating	Intercept	tender	juicy	flavour	Overall liking residual
3	-4.2989 ± 0.2082	0.0310 ± 0.0032	0.0206 ± 0.0035	0.0783 ± 0.0037	0.1084 ± 0.0065
4	-12.3748 ± 0.2840	0.0667 ± 0.0039	0.0395 ± 0.0040	0.1382 ± 0.0044	0.1918 ± 0.0078
5	-25.8636 ± 0.4605	0.1155 ± 0.0053	0.0705 ± 0.0048	0.2123 ± 0.0057	0.2929 ± 0.0101

Topside

Star rating	Intercept	tender	juicy	flavour	Overall liking residual
3	-4.9882 ± 0.1188	0.0475 ±0.0020	0.0189 ± 0.0021	0.0609 ± 0.0022	0.0979 ± 0.0038
4	-13.8642 ± 0.2554	0.0941 ± 0.0032	0.0372 ± 0.0033	0.1108 ± 0.0037	0.1802 ± 0.0063
5	-26.4121 ± 0.6852	0.1426 ± 0.0067	0.0573 ± 0.0060	0.1788 ± 0.0080	0.2612 ± 0.0131

Table 21.5. The variance components for the optimal discriminant functions for the loin and topside cuts with full data set and clipped data set clipped at absolute(residual) <= 5

	Loin		Topside	
Random Effect	Full data	Clipped data	Full data	Clipped data
Consumer within Pick	1.05	1.64	64.33	37.15
Pick	0.06	0.21	3.36	3.98
Sire with sire breed within Kill group:	0.11	0.11	9.68	5.39
Kill group	0.03	0.11	3.70	3.50
Residual	1.49	0.34	106.53	11.78

Table 22.5. Sire BLUP estimates and the ranks for the value of the clipped discriminant functions for the loin and topside cuts

Sire	Breed	Clipped Discriminant Loin	Rank Loin	Clipped Discriminant Topside	Rank Topside
s0600032006060121	Bond	6.35	98	3.72	159
s020041200707J039	Border Leicester	6.40	82	4.07	38
s0219292007070261	Border Leicester	6.38	86	4.07	39
s0236662006060976	Border	6.38	87	4.04	43

	Leicester				
s0236912008088370	Border Leicester	6.38	88	4.01	51
s0237802008080157	Border Leicester	6.37	92	4.00	53
s0241662008080220	Border Leicester	6.37	93	3.98	60
s0244112006060369	Border Leicester	6.36	94	3.96	66
s0246862007070179	Border Leicester	6.36	95	3.94	71
s0247152008080085	Border Leicester	6.33	104	3.91	91
s0250022008085029	Border Leicester	6.30	113	3.88	107
s1500152003030196	Coopworth	6.24	127	4.05	42
s1500292007070244	Coopworth	6.22	129	4.00	55
s1500292008080181	Coopworth	6.22	130	3.98	57
s1500392006061009	Coopworth	6.21	132	3.98	59
s1500482007070769	Coopworth	6.20	133	3.98	61
s1500482008080808	Coopworth	6.19	134	3.95	69
s1500992007071449	Coopwort h	6.19	135	3.91	89
s1500992007071449	Coopwort h	6.18	137	3.88	114
s0300182004045220	Corriedale	6.59	10	3.92	85
s0300362005050134	Corriedale	6.59	13	3.88	105
s0314602006543022	Corriedale	6.56	21	3.87	116
s0315272003030360	Corriedale	6.54	33	3.86	118
s0318972006060386	Corriedale	6.53	35	3.84	133
s0318972008080282	Corriedale	6.52	45	3.79	144
s0319232001011072	Corriedale	6.50	48	3.79	148
s0322722008080072	Corriedale	6.48	58	3.77	153
s0323612006060209	Corriedale	6.47	59	3.76	154
s0324012007070002	Corriedale	6.41	78	3.73	158
s5100032007070949	Dohne Merino	6.36	96	4.37	8
s5100072008083953	Dohne Merino	6.34	101	4.35	11
s5100072008084048	Dohne Merino	6.34	102	4.26	18
s5100092007070376	Dohne Merino	6.34	103	4.25	20
s5100292008088124	Dohne Merino	6.32	107	4.22	24
s5100302005050068	Dohne Merino	6.31	110	4.20	26
s5100492007071700	Dohne Merino	6.30	111	4.19	28
s5100732007070006	Dohne Merino	6.27	120	4.15	29
s5101402006060368	Dohne Merino	6.26	123	4.13	31

s5101462007070128	Dohne Merino	6.24	128	4.10	34
s4000302007070056	Dorper	6.58	16	4.34	12
s4000302007070617	Dorper	6.25	125	4.19	27
s4000302007071209	Dorper	6.18	136	4.02	49
s5000482007070260	Merino	6.65	1	3.96	67
s5000872006060096	Merino	6.63	2	3.95	70
s5003182007070022	Merino	6.63	3	3.94	73
s5007882007071254	Merino	6.63	4	3.94	74
s5007882008081290	Merino	6.60	7	3.92	83
s5015522006060480	Merino	6.59	8	3.91	92
s501587200606M276	Merino	6.59	9	3.90	99
s5017042007L68007	Merino	6.59	11	3.90	101
s5018852006TRIMPH	Merino	6.57	17	3.88	106
s5022512006066030	Merino	6.57	19	3.88	109
s5023022006006580	Merino	6.56	20	3.87	115
s5024252006023997	Merino	6.56	22	3.86	119
s5030542004040585	Merino	6.56	23	3.86	122
s5030702008080121	Merino	6.56	24	3.85	125
s5030972005051737	Merino	6.56	26	3.85	126
s5034252006060205	Merino	6.55	28	3.85	127
s5035642007WHI393	Merino	6.55	29	3.85	129
s5037892007LB0753	Merino	6.54	31	3.84	134
s5037892008080124	Merino	6.54	32	3.82	135
s5038632006OL3626	Merino	6.53	37	3.82	137
s5038842008081981	Merino	6.53	38	3.81	138
s5039462007OLY716	Merino	6.53	39	3.81	139
s5039822006060225	Merino	6.53	40	3.80	141
s5043622006LON449	Merino	6.52	41	3.80	142
s5044702006060022	Merino	6.52	43	3.79	143
s5044702008080588	Merino	6.52	44	3.79	145
s5044822007070461	Merino	6.50	49	3.79	146
s5046152004040024	Merino	6.49	52	3.79	147
s5047432000000503	Merino	6.49	54	3.78	149
s5049022005005345	Merino	6.49	55	3.78	151
s5049162007070719	Merino	6.48	56	3.75	155
s5049162008080600	Merino	6.46	63	3.74	156
s50505020080G0856	Merino	6.45	65	3.74	157
s50923420060C0573	Merino	6.45	67	3.67	160
s1600012008080010	Poll Dorset	5.96	161	3.54	161
s1600852008080021	Poll Dorset	5.94	162	3.48	162
s1601852007070369	Poll Dorset	5.91	163	3.47	163
s1603362008080541	Poll Dorset	5.90	164	3.46	164
s1611432007070025	Poll Dorset	5.88	165	3.45	165
s1611432008080203	Poll Dorset	5.88	166	3.45	166
s1611582007070190	Poll Dorset	5.86	167	3.44	167

s1612352007072025	Poll Dorset	5.86	168	3.43	168
s1612352008080608	Poll Dorset	5.86	169	3.43	169
s1614152007070440	Poll Dorset	5.85	170	3.41	170
s1618862008080157	Poll Dorset	5.84	171	3.41	171
s1618922006060050	Poll Dorset	5.84	172	3.41	172
s1619722006061831	Poll Dorset	5.83	173	3.41	173
s1619722009090133	Poll Dorset	5.83	174	3.40	174
s1622882007070644	Poll Dorset	5.83	175	3.39	175
s1622882008080077	Poll Dorset	5.83	176	3.38	176
s1623682007070468	Poll Dorset	5.83	177	3.38	177
s1627502008080481	Poll Dorset	5.82	178	3.37	178
s1629472008080219	Poll Dorset	5.82	179	3.37	179
s1635282007070182	Poll Dorset	5.81	180	3.35	180
s1636772007070839	Poll Dorset	5.80	181	3.34	181
s1636772008081037	Poll Dorset	5.80	182	3.34	182
s1637212007070311	Poll Dorset	5.78	183	3.33	183
s1640002009090052	Poll Dorset	5.78	184	3.31	184
s1640732007070364	Poll Dorset	5.74	185	3.29	185
s6001052007071080	Poll Merino	6.53	34	4.12	32
s6004082007070069	Poll Merino	6.52	42	4.05	41
s6005532007070002	Poll Merino	6.50	47	4.04	46
s6005712006060058	Poll Merino	6.49	51	4.02	50
s6005712006060904	Poll Merino	6.48	57	4.00	54
s6008152006060120	Poll Merino	6.47	60	3.98	58
s6008152007070323	Poll Merino	6.46	61	3.97	62
s6008802006060627	Poll Merino	6.46	62	3.94	76
s6010532003031078	Poll Merino	6.45	66	3.94	77

s6010532007071190	Poll Merino	6.44	68	3.94	79
s6010822007071257	Poll Merino	6.44	69	3.93	81
s6010822008081288	Poll Merino	6.44	70	3.92	82
s6011272007070121	Poll Merino	6.42	72	3.92	84
s6011272008088254	Poll Merino	6.42	73	3.92	86
s6012442007070304	Poll Merino	6.41	76	3.91	88
s6012502004407812	Poll Merino	6.41	77	3.91	93
s6012792007070470	Poll Merino	6.41	79	3.89	102
s6012882006063091	Poll Merino	6.40	80	3.89	103
s6013072005050165	Poll Merino	6.40	81	3.88	108
s6013162007070023	Poll Merino	6.39	83	3.88	111
s6013322004000WD2	Poll Merino	6.38	85	3.88	112
s6013362008RAS004	Poll Merino	6.38	89	3.88	113
s6013562007000449	Poll Merino	6.37	90	3.86	124
s6013652006060052	Poll Merino	6.37	91	3.84	130
s6090542006066533	Poll Merino	6.35	97	3.80	140
s6091542004040062	Poll Merino	6.34	100	3.78	150
s6091542006060306	Poll Merino	6.33	105	3.77	152
s4800302008080078	Prime Samm	6.63	5	4.40	6
s4800302008080111	Prime Samm	6.61	6	4.39	7
s4800392007070062	Prime Samm	6.59	12	4.36	9
s4800402008080217	Prime Samm	6.59	14	4.35	10
s4800552007070068	Prime Samm	6.58	15	4.30	14
s4800872006060421	Prime Samm	6.57	18	4.28	16
s4800992006060191	Prime Samm	6.56	25	4.26	17
s4801042008080549	Prime Samm	6.55	27	4.26	19
s4801222005051010	Prime Samm	6.54	30	4.25	21

s4801222008080343	Prime Samm	6.53	36	4.24	22
s1900282007071494	Suffolk	6.39	84	4.23	23
s1900602007070267	Suffolk	6.32	106	4.22	25
s1900602008080369	Suffolk	6.31	109	4.13	30
s1901112007077058	Suffolk	6.30	112	4.10	33
s1912012008080094	Suffolk	6.29	114	4.10	35
s1913622007070027	Suffolk	6.29	115	4.09	36
s1916612008080491	Suffolk	6.29	117	4.07	37
s1918502001010120	Suffolk	6.25	124	4.04	44
s1920452007070508	Suffolk	6.24	126	4.03	47
s1920452008080594	Suffolk	6.21	131	4.00	56
s1700622007070144	Texel	6.35	99	4.04	45
s1700802007071532	Texel	6.31	108	4.00	52
s1700812008080039	Texel	6.29	116	3.97	63
s1702232004040080	Texel	6.29	118	3.96	68
s1702232007070046	Texel	6.28	119	3.94	72
s1704062007070028	Texel	6.26	121	3.94	75
s1704202007070224	Texel	6.26	122	3.92	87
s4700442008084825	White Dorper	6.51	46	4.54	1
s4700702003030011	White Dorper	6.50	50	4.50	2
s4701142006060036	White Dorper	6.49	53	4.44	3
s4701142007071345	White Dorper	6.45	64	4.43	4
s4701392006060057	White Dorper	6.43	71	4.42	5
s4701792008080386	White Dorper	6.42	74	4.31	13
s4702062007077118	White Dorper	6.42	75	4.29	15
s2300012008080022	White Suffolk	6.16	138	4.06	40
s2300022007070098	White Suffolk	6.13	139	4.03	48
s2300022008080234	White Suffolk	6.11	140	3.96	64
s2300092007070279	White Suffolk	6.10	141	3.96	65
s2300152007070143	White Suffolk	6.10	142	3.94	78
s2300152009090255	White Suffolk	6.10	143	3.93	80
s2300262005050650	White Suffolk	6.10	144	3.91	90
s2300262007072446	White Suffolk	6.10	145	3.90	94
s2300262008083813	White Suffolk	6.09	146	3.90	95
s2300302008080116	White Suffolk	6.09	147	3.90	96

s2300342007074914	White Suffolk	6.08	148	3.90	97
s2300432007070591	White Suffolk	6.08	149	3.90	98
s2300432008080136	White Suffolk	6.07	150	3.90	100
s2300432008080644	White Suffolk	6.07	151	3.89	104
s2300912007070008	White Suffolk	6.06	152	3.88	110
s2300992008080097	White Suffolk	6.06	153	3.87	117
s2301002007070677	White Suffolk	6.06	154	3.86	120
s2301132007070040	White Suffolk	6.04	155	3.86	121
s2301132008080205	White Suffolk	6.04	156	3.86	123
s2303182008080262	White Suffolk	6.04	157	3.85	128
s2303242007075630	White Suffolk	6.03	158	3.84	131
s2303242008085244	White Suffolk	6.01	159	3.84	132
s2304502007071456	White Suffolk	6.00	160	3.82	136

Table 23.5. Probabilities of a sire producing progeny within each of the star eating classification classes for the loin cut

Sire	Breed	Prob star 2	Prob star 3	Prob star 4	Prob star 5
s0600032006060121	Bond	0.04	0.31	0.37	0.28
s020041200707J039	Border Leicester	0.05	0.34	0.35	0.25
s0219292007070261	Border Leicester	0.06	0.35	0.34	0.25
s0236662006060976	Border Leicester	0.05	0.37	0.34	0.24
s0236912008088370	Border Leicester	0.05	0.37	0.33	0.25
s0237802008080157	Border Leicester	0.05	0.35	0.34	0.25
s0241662008080220	Border Leicester	0.07	0.36	0.33	0.25
s0244112006060369	Border Leicester	0.05	0.34	0.34	0.27
s0246862007070179	Border Leicester	0.05	0.36	0.34	0.25
s0247152008080085	Border Leicester	0.06	0.36	0.34	0.23
s0250022008085029	Border Leicester	0.06	0.37	0.33	0.24
s020041200707J040	Border Leicester	0.04	0.34	0.36	0.26
s1500152003030196	Coopworth	0.07	0.36	0.34	0.23
s1500292007070244	Coopworth	0.07	0.36	0.35	0.23
s1500292008080181	Coopworth	0.07	0.34	0.35	0.24
s1500392006061009	Coopworth	0.07	0.35	0.35	0.24
s1500482007070769	Coopworth	0.08	0.35	0.35	0.23
s1500482008080808	Coopworth	0.08	0.36	0.34	0.22
s1500992007071449	Coopworth	0.06	0.35	0.35	0.24
s1500992007071449	Coopworth	0.07	0.36	0.34	0.22

s0300182004045220	Corriedale	0.05	0.33	0.35	0.27
s0300362005050134	Corriedale	0.05	0.30	0.35	0.29
s0314602006543022	Corriedale	0.05	0.32	0.35	0.28
s0315272003030360	Corriedale	0.05	0.35	0.36	0.23
s0318972006060386	Corriedale	0.06	0.33	0.35	0.27
s0318972008080282	Corriedale	0.05	0.32	0.35	0.28
s0319232001011072	Corriedale	0.04	0.31	0.36	0.28
s0322722008080072	Corriedale	0.07	0.34	0.34	0.26
s0323612006060209	Corriedale	0.06	0.31	0.35	0.28
s0324012007070002	Corriedale	0.05	0.33	0.35	0.27
s5100032007070949	Dohne Merino	0.05	0.35	0.36	0.23
s5100072008083953	Dohne Merino	0.05	0.34	0.36	0.25
s5100072008084048	Dohne Merino	0.05	0.33	0.36	0.27
s5100092007070376	Dohne Merino	0.05	0.34	0.36	0.24
s5100292008088124	Dohne Merino	0.05	0.34	0.37	0.24
s5100302005050068	Dohne Merino	0.06	0.36	0.35	0.23
s5100492007071700	Dohne Merino	0.05	0.35	0.35	0.24
s5100732007070006	Dohne Merino	0.06	0.35	0.35	0.24
s5101402006060368	Dohne Merino	0.05	0.35	0.36	0.24
s5101462007070128	Dohne Merino	0.05	0.34	0.36	0.25
s4000302007070056	Dorper	0.07	0.34	0.34	0.24
s4000302007070617	Dorper	0.07	0.38	0.35	0.20
s4000302007071209	Dorper	0.04	0.36	0.36	0.25
s5000482007070260	Merino	0.05	0.33	0.36	0.26
s5000872006060096	Merino	0.04	0.30	0.38	0.29
s5003182007070022	Merino	0.04	0.32	0.38	0.25
s5007882007071254	Merino	0.05	0.30	0.37	0.28
s5007882008081290	Merino	0.04	0.33	0.37	0.25
s5015522006060480	Merino	0.04	0.31	0.37	0.27
s501587200606M276	Merino	0.05	0.33	0.35	0.27
s5017042007L68007	Merino	0.04	0.33	0.37	0.25
s5018852006TRIMPH	Merino	0.05	0.31	0.37	0.26
s5022512006066030	Merino	0.04	0.32	0.38	0.25
s5023022006006580	Merino	0.04	0.33	0.37	0.25
s5024252006023997	Merino	0.06	0.34	0.36	0.24
s5030542004040585	Merino	0.04	0.32	0.38	0.26
s5030702008080121	Merino	0.04	0.32	0.37	0.26
s5030972005051737	Merino	0.05	0.32	0.37	0.26
s5034252006060205	Merino	0.05	0.31	0.36	0.29
s5035642007WHI393	Merino	0.04	0.31	0.38	0.26
s5037892007LB0753	Merino	0.04	0.31	0.37	0.28
s5037892008080124	Merino	0.05	0.34	0.37	0.24
s5038632006OL3626	Merino	0.05	0.32	0.37	0.25
s5038842008081981	Merino	0.06	0.32	0.36	0.25
s5039462007OLY716	Merino	0.05	0.33	0.37	0.26
s5039822006060225	Merino	0.05	0.33	0.37	0.25
s5043622006LON449	Merino	0.04	0.33	0.38	0.25
s5044702006060022	Merino	0.05	0.32	0.37	0.26
s5044702008080588	Merino	0.07	0.32	0.37	0.24
s5044822007070461	Merino	0.06	0.33	0.37	0.23
s5046152004040024	Merino	0.05	0.32	0.37	0.26
s5047432000000503	Merino	0.05	0.29	0.38	0.29
s5049022005005345	Merino	0.04	0.36	0.37	0.23

s5049162007070719	Merino	0.05	0.32	0.37	0.26
s5049162008080600	Merino	0.05	0.36	0.36	0.22
s50505020080G0856	Merino	0.07	0.31	0.36	0.27
s50923420060C0573	Merino	0.05	0.34	0.37	0.24
s1600012008080010	Poll Dorset	0.09	0.40	0.32	0.19
s1600852008080021	Poll Dorset	0.10	0.42	0.32	0.17
s1601852007070369	Poll Dorset	0.10	0.42	0.31	0.17
s1603362008080541	Poll Dorset	0.08	0.42	0.32	0.18
s1611432007070025	Poll Dorset	0.08	0.42	0.32	0.18
s1611432008080203	Poll Dorset	0.09	0.39	0.33	0.20
s1611582007070190	Poll Dorset	0.10	0.41	0.31	0.19
s1612352007072025	Poll Dorset	0.09	0.43	0.32	0.17
s1612352008080608	Poll Dorset	0.09	0.39	0.32	0.19
s1614152007070440	Poll Dorset	0.09	0.42	0.31	0.17
s1618862008080157	Poll Dorset	0.09	0.41	0.32	0.19
s1618922006060050	Poll Dorset	0.09	0.41	0.32	0.19
s1619722006061831	Poll Dorset	0.08	0.39	0.33	0.21
s1619722009090133	Poll Dorset	0.10	0.39	0.32	0.19
s1622882007070644	Poll Dorset	0.07	0.38	0.34	0.21
s1622882008080077	Poll Dorset	0.09	0.40	0.32	0.19
s1623682007070468	Poll Dorset	0.12	0.40	0.31	0.18
s1627502008080481	Poll Dorset	0.08	0.42	0.32	0.18
s1629472008080219	Poll Dorset	0.09	0.41	0.32	0.19
s1635282007070182	Poll Dorset	0.12	0.43	0.30	0.17
s1636772007070839	Poll Dorset	0.11	0.42	0.31	0.17
s1636772008081037	Poll Dorset	0.10	0.38	0.32	0.20
s1637212007070311	Poll Dorset	0.09	0.38	0.32	0.23
s1640002009090052	Poll Dorset	0.09	0.40	0.32	0.20
s1640732007070364	Poll Dorset	0.09	0.39	0.32	0.20
s6001052007071080	Poll Merino	0.04	0.37	0.36	0.23
s6004082007070069	Poll Merino	0.05	0.34	0.36	0.25
s6005532007070002	Poll Merino	0.05	0.35	0.35	0.25
s6005712006060058	Poll Merino	0.05	0.34	0.35	0.25
s6005712006060904	Poll Merino	0.05	0.34	0.35	0.26
s6008152006060120	Poll Merino	0.04	0.31	0.36	0.28
s6008152007070323	Poll Merino	0.05	0.34	0.35	0.27
s6008802006060627	Poll Merino	0.04	0.34	0.36	0.26
s6010532003031078	Poll Merino	0.04	0.33	0.37	0.26
s6010532007071190	Poll Merino	0.05	0.33	0.36	0.27
s6010822007071257	Poll Merino	0.04	0.32	0.36	0.28
s6010822008081288	Poll Merino	0.05	0.34	0.37	0.25
s6011272007070121	Poll Merino	0.04	0.34	0.36	0.26
s6011272008088254	Poll Merino	0.06	0.36	0.35	0.24
s6012442007070304	Poll Merino	0.04	0.32	0.36	0.28
s6012502004407812	Poll Merino	0.04	0.36	0.36	0.24
s6012792007070470	Poll Merino	0.04	0.35	0.36	0.25
s6012882006063091	Poll Merino	0.05	0.35	0.35	0.25
s6013072005050165	Poll Merino	0.05	0.35	0.35	0.25
s6013162007070023	Poll Merino	0.05	0.33	0.36	0.26
s6013322004000WD2	Poll Merino	0.04	0.32	0.35	0.29
s6013362008RAS004	Poll Merino	0.05	0.35	0.36	0.24
s6013562007000449	Poll Merino	0.04	0.34	0.36	0.25
s6013652006060052	Poll Merino	0.06	0.35	0.35	0.25

s6090542006066533	Poll Merino	0.05	0.34	0.36	0.24
s6091542004040062	Poll Merino	0.07	0.34	0.35	0.25
s4800302008080078	Prime Samm	0.04	0.30	0.36	0.30
s4800302008080111	Prime Samm	0.04	0.31	0.35	0.29
s4800392007070062	Prime Samm	0.05	0.30	0.35	0.30
s4800402008080217	Prime Samm	0.04	0.30	0.35	0.31
s4800552007070068	Prime Samm	0.05	0.31	0.35	0.30
s4800872006060421	Prime Samm	0.05	0.32	0.35	0.29
s4800992006060191	Prime Samm	0.06	0.32	0.34	0.28
s4801042008080549	Prime Samm	0.05	0.31	0.35	0.29
s4801222005051010	Prime Samm	0.04	0.29	0.36	0.31
s4801222008080343	Prime Samm	0.04	0.31	0.35	0.30
s1900282007071494	Suffolk	0.06	0.35	0.34	0.24
s1900602007070267	Suffolk	0.06	0.38	0.34	0.22
s1900602008080369	Suffolk	0.07	0.35	0.34	0.25
s1901112007077058	Suffolk	0.06	0.36	0.35	0.23
s1912012008080094	Suffolk	0.06	0.37	0.34	0.23
s1913622007070027	Suffolk	0.07	0.36	0.35	0.23
s1916612008080491	Suffolk	0.07	0.37	0.34	0.21
s1918502001010120	Suffolk	0.06	0.36	0.34	0.23
s1920452007070508	Suffolk	0.07	0.37	0.34	0.22
s1920452008080594	Suffolk	0.06	0.36	0.35	0.23
s1700622007070144	Texel	0.06	0.34	0.35	0.25
s1700802007071532	Texel	0.06	0.34	0.35	0.25
s1700812008080039	Texel	0.05	0.36	0.35	0.24
s1702232004040080	Texel	0.07	0.35	0.34	0.24
s1702232007070046	Texel	0.07	0.36	0.35	0.23
s1704062007070028	Texel	0.07	0.35	0.34	0.23
s1704202007070224	Texel	0.05	0.35	0.35	0.24
s4700442008084825	White Dorper	0.05	0.32	0.37	0.26
s4700702003030011	White Dorper	0.05	0.34	0.37	0.24
s4701142006060036	White Dorper	0.06	0.36	0.36	0.22
s4701142007071345	White Dorper	0.05	0.34	0.35	0.26
s4701392006060057	White Dorper	0.07	0.34	0.34	0.25
s4701792008080386	White Dorper	0.07	0.31	0.37	0.24
s4702062007077118	White Dorper	0.05	0.31	0.37	0.28
s2300012008080022	White Suffolk	0.07	0.39	0.34	0.21
s2300022007070098	White Suffolk	0.08	0.38	0.33	0.21
s2300022008080234	White Suffolk	0.07	0.38	0.34	0.21
s2300092007070279	White Suffolk	0.07	0.39	0.34	0.20
s2300152007070143	White Suffolk	0.08	0.37	0.35	0.20
s2300152009090255	White Suffolk	0.06	0.39	0.35	0.19
s2300262005050650	White Suffolk	0.06	0.36	0.35	0.23
s2300262007072446	White Suffolk	0.07	0.38	0.34	0.21
s2300262008083813	White Suffolk	0.08	0.38	0.34	0.21
s2300302008080116	White Suffolk	0.08	0.38	0.33	0.21
s2300342007074914	White Suffolk	0.08	0.38	0.33	0.22
s2300432007070591	White Suffolk	0.07	0.40	0.34	0.20
s2300432008080136	White Suffolk	0.08	0.39	0.34	0.19
s2300432008080644	White Suffolk	0.07	0.39	0.34	0.20
s2300912007070008	White Suffolk	0.07	0.39	0.34	0.21
s2300992008080097	White Suffolk	0.07	0.37	0.34	0.22
s2301002007070677	White Suffolk	0.05	0.36	0.35	0.23

s2301132007070040	White Suffolk	0.07	0.38	0.34	0.21
s2301132008080205	White Suffolk	0.07	0.38	0.35	0.21
s2303182008080262	White Suffolk	0.07	0.37	0.35	0.21
s2303242007075630	White Suffolk	0.07	0.40	0.34	0.19
s2303242008085244	White Suffolk	0.07	0.38	0.34	0.20
s2304502007071456	White Suffolk	0.07	0.38	0.35	0.21

Table 24.5. Probabilities of a sire producing progeny within each of the star eating classification classes for the topside cut

Sire	Breed	Prob star 2	Prob star 3	Prob star 4	Prob star 5
s0600032006060121	Bond	0.25	0.49	0.18	0.06
s020041200707J039	Border Leicester	0.25	0.5	0.17	0.06
s0219292007070261	Border Leicester	0.30	0.49	0.16	0.06
s0236662006060976	Border Leicester	0.29	0.50	0.16	0.05
s0236912008088370	Border Leicester	0.29	0.49	0.17	0.06
s0237802008080157	Border Leicester	0.29	0.48	0.17	0.06
s0241662008080220	Border Leicester	0.29	0.49	0.17	0.06
s0244112006060369	Border Leicester	0.25	0.48	0.20	0.07
s0246862007070179	Border Leicester	0.30	0.49	0.16	0.06
s0247152008080085	Border Leicester	0.28	0.50	0.16	0.05
s0250022008085029	Border Leicester	0.27	0.50	0.17	0.05
s020041200707J040	Border Leicester	0.30	0.50	0.15	0.05
s1500152003030196	Coopworth	0.35	0.48	0.15	0.05
s1500292007070244	Coopworth	0.33	0.48	0.15	0.05
s1500292008080181	Coopworth	0.30	0.50	0.15	0.05
s1500392006061009	Coopworth	0.27	0.51	0.15	0.05
s1500482007070769	Coopworth	0.31	0.50	0.15	0.05
s1500482008080808	Coopworth	0.28	0.49	0.17	0.06
s1500992007071449	Coopworth	0.29	0.50	0.14	0.05
s1500992007071449	Coopworth	0.32	0.49	0.15	0.05
s0300182004045220	Corriedale	0.31	0.48	0.17	0.05
s0300362005050134	Corriedale	0.25	0.48	0.21	0.06
s0314602006543022	Corriedale	0.27	0.50	0.17	0.05
s0315272003030360	Corriedale	0.30	0.49	0.17	0.05
s0318972006060386	Corriedale	0.30	0.50	0.16	0.05
s0318972008080282	Corriedale	0.26	0.50	0.18	0.05
s0319232001011072	Corriedale	0.25	0.50	0.17	0.05
s0322722008080072	Corriedale	0.32	0.47	0.16	0.05
s0323612006060209	Corriedale	0.23	0.50	0.19	0.06
s0324012007070002	Corriedale	0.35	0.48	0.15	0.05
s5100032007070949	Dohne Merino	0.31	0.51	0.14	0.05
s5100072008083953	Dohne Merino	0.23	0.53	0.17	0.05
s5100072008084048	Dohne Merino	0.25	0.51	0.17	0.06
s5100092007070376	Dohne Merino	0.30	0.51	0.15	0.05
s5100292008088124	Dohne Merino	0.31	0.51	0.15	0.05
s5100302005050068	Dohne Merino	0.28	0.52	0.15	0.05
s5100492007071700	Dohne Merino	0.28	0.50	0.16	0.05
s5100732007070006	Dohne Merino	0.31	0.51	0.14	0.05
s5101402006060368	Dohne Merino	0.27	0.51	0.17	0.05
s5101462007070128	Dohne Merino	0.32	0.50	0.14	0.05
s4000302007070056	Dorper	0.25	0.51	0.18	0.06
s4000302007070617	Dorper	0.28	0.52	0.15	0.05
s4000302007071209	Dorper	0.30	0.50	0.16	0.06
s5000482007070260	Merino	0.27	0.51	0.16	0.05
s5000872006060096	Merino	0.27	0.52	0.16	0.04
s5003182007070022	Merino	0.32	0.51	0.14	0.04
s5007882007071254	Merino	0.23	0.51	0.17	0.05
s5007882008081290	Merino	0.29	0.49	0.16	0.05

s5015522006060480	Merino	0.25	0.51	0.17	0.05
s501587200606M276	Merino	0.30	0.49	0.16	0.05
s5017042007L68007	Merino	0.26	0.52	0.15	0.05
s5018852006TRIMPH	Merino	0.28	0.49	0.17	0.05
s5022512006066030	Merino	0.30	0.52	0.13	0.04
s5023022006006580	Merino	0.30	0.49	0.15	0.05
s5024252006023997	Merino	0.34	0.49	0.14	0.04
s5030542004040585	Merino	0.33	0.48	0.15	0.05
s5030702008080121	Merino	0.28	0.51	0.15	0.05
s5030972005051737	Merino	0.30	0.52	0.13	0.04
s5034252006060205	Merino	0.27	0.50	0.16	0.05
s5035642007WHI393	Merino	0.25	0.52	0.16	0.05
s5037892007LB0753	Merino	0.25	0.51	0.16	0.06
s5037892008080124	Merino	0.31	0.50	0.15	0.04
s5038632006OL3626	Merino	0.24	0.52	0.15	0.04
s5038842008081981	Merino	0.35	0.48	0.14	0.05
s5039462007OLY716	Merino	0.32	0.49	0.15	0.05
s5039822006060225	Merino	0.28	0.51	0.16	0.05
s5043622006LON449	Merino	0.25	0.51	0.16	0.05
s5044702006060022	Merino	0.29	0.51	0.15	0.04
s5044702008080588	Merino	0.29	0.51	0.15	0.05
s5044822007070461	Merino	0.30	0.50	0.15	0.04
s5046152004040024	Merino	0.31	0.50	0.14	0.04
s5047432000000503	Merino	0.33	0.48	0.15	0.05
s5049022005005345	Merino	0.37	0.48	0.13	0.04
s5049162007070719	Merino	0.30	0.50	0.15	0.05
s5049162008080600	Merino	0.30	0.50	0.15	0.05
s50505020080G0856	Merino	0.28	0.51	0.15	0.04
s50923420060C0573	Merino	0.29	0.51	0.16	0.05
s1600012008080010	Poll Dorset	0.35	0.49	0.12	0.03
s1600852008080021	Poll Dorset	0.44	0.46	0.10	0.03
s1601852007070369	Poll Dorset	0.37	0.48	0.12	0.04
s1603362008080541	Poll Dorset	0.41	0.46	0.12	0.04
s1611432007070025	Poll Dorset	0.35	0.49	0.11	0.03
s1611432008080203	Poll Dorset	0.35	0.49	0.12	0.04
s1611582007070190	Poll Dorset	0.38	0.47	0.12	0.04
s1612352007072025	Poll Dorset	0.35	0.50	0.11	0.03
s1612352008080608	Poll Dorset	0.41	0.47	0.11	0.03
s1614152007070440	Poll Dorset	0.36	0.49	0.12	0.03
s1618862008080157	Poll Dorset	0.31	0.49	0.14	0.03
s1618922006060050	Poll Dorset	0.37	0.49	0.11	0.03
s1619722006061831	Poll Dorset	0.32	0.49	0.13	0.04
s1619722009090133	Poll Dorset	0.32	0.50	0.13	0.04
s1622882007070644	Poll Dorset	0.31	0.51	0.12	0.03
s1622882008080077	Poll Dorset	0.32	0.49	0.14	0.04
s1623682007070468	Poll Dorset	0.36	0.48	0.12	0.04
s1627502008080481	Poll Dorset	0.38	0.47	0.12	0.03
s1629472008080219	Poll Dorset	0.34	0.49	0.13	0.03
s1635282007070182	Poll Dorset	0.38	0.47	0.13	0.04
s1636772007070839	Poll Dorset	0.42	0.47	0.10	0.03
s1636772008081037	Poll Dorset	0.40	0.47	0.12	0.03
s1637212007070311	Poll Dorset	0.32	0.49	0.13	0.04
s1640002009090052	Poll Dorset	0.40	0.48	0.10	0.03

s1640732007070364	Poll Dorset	0.35	0.48	0.13	0.04
s6001052007071080	Poll Merino	0.35	0.49	0.14	0.05
s6004082007070069	Poll Merino	0.27	0.51	0.16	0.05
s6005532007070002	Poll Merino	0.28	0.51	0.16	0.05
s6005712006060058	Poll Merino	0.29	0.50	0.16	0.06
s6005712006060904	Poll Merino	0.29	0.50	0.16	0.05
s6008152006060120	Poll Merino	0.28	0.50	0.16	0.05
s6008152007070323	Poll Merino	0.34	0.49	0.14	0.05
s6008802006060627	Poll Merino	0.27	0.51	0.15	0.05
s6010532003031078	Poll Merino	0.31	0.49	0.15	0.05
s6010532007071190	Poll Merino	0.23	0.51	0.18	0.06
s6010822007071257	Poll Merino	0.22	0.54	0.15	0.05
s6010822008081288	Poll Merino	0.23	0.50	0.17	0.07
s6011272007070121	Poll Merino	0.28	0.51	0.14	0.05
s6011272008088254	Poll Merino	0.36	0.48	0.14	0.05
s6012442007070304	Poll Merino	0.25	0.51	0.17	0.05
s6012502004407812	Poll Merino	0.32	0.50	0.14	0.05
s6012792007070470	Poll Merino	0.30	0.49	0.16	0.05
s6012882006063091	Poll Merino	0.27	0.50	0.16	0.05
s6013072005050165	Poll Merino	0.29	0.49	0.16	0.05
s6013162007070023	Poll Merino	0.25	0.51	0.17	0.05
s6013322004000WD2	Poll Merino	0.28	0.48	0.17	0.06
s6013362008RAS004	Poll Merino	0.34	0.49	0.14	0.05
s6013562007000449	Poll Merino	0.23	0.51	0.17	0.05
s6013652006060052	Poll Merino	0.29	0.53	0.12	0.05
s6090542006066533	Poll Merino	0.34	0.49	0.14	0.05
s6091542004040062	Poll Merino	0.35	0.47	0.15	0.05
s4800302008080078	Prime Samm	0.26	0.51	0.17	0.06
s4800302008080111	Prime Samm	0.28	0.51	0.16	0.05
s4800392007070062	Prime Samm	0.23	0.52	0.18	0.05
s4800402008080217	Prime Samm	0.23	0.52	0.18	0.06
s4800552007070068	Prime Samm	0.23	0.52	0.18	0.05
s4800872006060421	Prime Samm	0.26	0.50	0.18	0.06
s4800992006060191	Prime Samm	0.26	0.52	0.16	0.05
s4801042008080549	Prime Samm	0.27	0.51	0.17	0.05
s4801222005051010	Prime Samm	0.21	0.52	0.19	0.06
s4801222008080343	Prime Samm	0.24	0.51	0.19	0.06
s1900282007071494	Suffolk	0.30	0.51	0.14	0.05
s1900602007070267	Suffolk	0.30	0.51	0.14	0.05
s1900602008080369	Suffolk	0.25	0.52	0.16	0.05
s1901112007077058	Suffolk	0.24	0.52	0.17	0.05
s1912012008080094	Suffolk	0.28	0.52	0.15	0.05
s1913622007070027	Suffolk	0.32	0.50	0.14	0.05
s1916612008080491	Suffolk	0.30	0.50	0.15	0.05
s1918502001010120	Suffolk	0.32	0.50	0.14	0.05
s1920452007070508	Suffolk	0.32	0.51	0.14	0.05
s1920452008080594	Suffolk	0.28	0.52	0.15	0.05
s1700622007070144	Texel	0.32	0.49	0.15	0.05
s1700802007071532	Texel	0.29	0.50	0.16	0.05
s1700812008080039	Texel	0.30	0.50	0.15	0.05
s1702232004040080	Texel	0.29	0.50	0.15	0.05
s1702232007070046	Texel	0.28	0.51	0.16	0.05
s1704062007070028	Texel	0.33	0.49	0.15	0.05

s1704202007070224	Texel	0.28	0.51	0.15	0.05
s4700442008084825	White Dorper	0.25	0.53	0.17	0.05
s4700702003030011	White Dorper	0.24	0.51	0.20	0.06
s4701142006060036	White Dorper	0.29	0.55	0.14	0.04
s4701142007071345	White Dorper	0.29	0.51	0.17	0.05
s4701392006060057	White Dorper	0.32	0.50	0.16	0.05
s4701792008080386	White Dorper	0.27	0.51	0.18	0.05
s4702062007077118	White Dorper	0.24	0.51	0.20	0.06
s2300012008080022	White Suffolk	0.34	0.49	0.12	0.04
s2300022007070098	White Suffolk	0.30	0.48	0.16	0.05
s2300022008080234	White Suffolk	0.30	0.50	0.14	0.04
s2300092007070279	White Suffolk	0.33	0.49	0.14	0.04
s2300152007070143	White Suffolk	0.32	0.49	0.15	0.04
s2300152009090255	White Suffolk	0.31	0.50	0.14	0.04
s2300262005050650	White Suffolk	0.36	0.49	0.13	0.04
s2300262007072446	White Suffolk	0.30	0.49	0.15	0.05
s2300262008083813	White Suffolk	0.34	0.49	0.14	0.04
s2300302008080116	White Suffolk	0.33	0.49	0.15	0.04
s2300342007074914	White Suffolk	0.32	0.48	0.14	0.05
s2300432007070591	White Suffolk	0.35	0.48	0.14	0.04
s2300432008080136	White Suffolk	0.37	0.48	0.13	0.04
s2300432008080644	White Suffolk	0.33	0.49	0.13	0.04
s2300912007070008	White Suffolk	0.35	0.49	0.13	0.04
s2300992008080097	White Suffolk	0.37	0.48	0.13	0.04
s2301002007070677	White Suffolk	0.29	0.51	0.14	0.04
s2301132007070040	White Suffolk	0.35	0.48	0.14	0.04
s2301132008080205	White Suffolk	0.33	0.50	0.13	0.04
s2303182008080262	White Suffolk	0.34	0.49	0.14	0.04
s2303242007075630	White Suffolk	0.34	0.50	0.13	0.04
s2303242008085244	White Suffolk	0.31	0.50	0.14	0.04
s2304502007071456	White Suffolk	0.32	0.49	0.15	0.05

Table 25.5. Variance components for meat colour measurements for the Loin and Topside cuts

	CFL	CFa	CFb
Sire	4.03	1.61	1.39
Kill group	2.98	0.52	7.01
Residual	2.16	0.59	0.69

Table 26.5. Least squares means for the sire breed for each of the meat colour measurements for the loin and Topside cuts.

Sire Breed	CFL	CFa	CFb
Bond	37.5 ± 1.15	20.3 ± 0.68	5.2 ± 0.94

Border Leicester	36.4 ± 0.60	19.5 ± 0.31	4.7 ± 0.75
Coopworth	36.2 ± 0.59	19.5 ± 0.30	4.6 ± 0.74
Corriedale	36.8 ± 0.60	19.6 ± 0.30	4.7 ± 0.74
Dohne Merino	36.4 ± 0.58	19.7 ± 0.29	4.8 ± 0.74
Dorper	37.6 ± 1.19	19.3 ± 0.69	5.8 ± 0.98
Merino	36.8 ± 0.54	19.4 ± 0.26	4.9 ± 0.73
Poll Dorset	36.9 ± 0.53	19.2 ± 0.25	4.8 ± 0.73
Poll Merino	36.8 ± 0.56	19.8 ± 0.28	4.8 ± 0.74
Prime Samm	38.1 ± 0.56	20.1 ± 0.27	5.4 ± 0.73
Suffolk	37.1 ± 0.62	19.2 ± 0.32	4.8 ± 0.75
Texel	37.9 ± 0.64	19.6 ± 0.34	5.2 ± 0.76
White Dorper	36.8 ± 0.94	19.2 ± 0.51	5.0 ± 0.88
White Suffolk	36.8 ± 0.53	19.3 ± 0.25	4.8 ± 0.73

Table 27.5. Sire breed comparisons for each of the meat colour measurements for the loin and Topside cuts.

CFL

Sire Breed Comparison			Difference in estimates	Significance
Prime Samm	v	Coopworth	1.95	0.01
Prime Samm	v	Dohne Merino	1.74	0.01
Prime Samm	v	Border Leicester	1.76	0.01

Prime Samm	v	White Suffolk	1.38	0.01
Prime Samm	v	Poll Dorset	1.27	0.03
Prime Samm	v	Merino	1.30	0.05

CFa

Sire Breed Comparison			Difference in estimates	Significance
Prime Samm	v	Poll Dorset	0.90	0.01
White Suffolk	v	Prime Samm	-0.78	0.04

CFb

No significant sire breed effects

Table 28.5. Sire within breed BLUP values for the meat colour measurements for the loin and Topside cuts.

Sire	Breed	CFL	Rank CFL	CFa	Rank CFa	CFb	Rank CFb
s0600032006060121	Bond	37.74	49	20.39	29	6.15	59
s0244112006060369	Border Leicester	39.95	6	21.54	8	7.31	7
s0236912008088370	Border Leicester	38.12	35	21.38	9	6.68	18
s0219292007070261	Border Leicester	38.07	36	20.64	20	6.66	19
s0246862007070179	Border Leicester	36.88	106	19.95	56	6.35	40
s0250022008085029	Border Leicester	36.57	120	19.29	114	6.29	44
s0236662006060976	Border Leicester	36.52	122	19.29	115	5.60	117
s0241662008080220	Border Leicester	35.79	153	19.22	121	5.02	158
s0247152008080085	Border Leicester	35.68	158	19.06	134	4.99	162
s0237802008080157	Border Leicester	35.38	167	18.97	141	4.97	163
s020041200707J039	Border Leicester	35.34	168	18.1	177	4.58	173
s1500152003030196	Coopworth	38.05	38	20.34	32	6.34	42
s1500392006061009	Coopworth	37.27	77	20.33	34	5.90	79
s1500482008080808	Coopworth	37.23	83	20.17	40	5.81	89
s1500992007071449	Coopworth	36.66	119	19.61	82	5.70	105
s1500992007071449	Coopworth	36.14	139	19.51	91	5.68	106
s1500482007070769	Coopworth	35.90	148	19.50	93	5.40	130
s1500292008080181	Coopworth	35.47	163	19.48	97	5.38	133

s1500292007070244	Coopworth	35.45	165	19.21	124	5.09	153
s0318972008080282	Corriedale	38.25	33	20.66	19	6.29	45
s0300182004045220	Corriedale	38.04	40	20.50	27	6.16	56
s0322722008080072	Corriedale	37.92	45	19.92	59	6.16	57
s0319232001011072	Corriedale	37.19	87	19.85	65	6.14	61
s0300362005050134	Corriedale	37.07	89	19.82	67	5.79	95
s0314602006543022	Corriedale	36.97	98	19.41	105	5.38	134
s0318972006060386	Corriedale	36.40	128	19.32	109	5.35	135
s0324012007070002	Corriedale	36.22	133	19.16	126	5.34	136
s0323612006060209	Corriedale	36.17	137	19.06	135	4.80	166
s0315272003030360	Corriedale	33.40	181	17.88	178	4.74	169
s5100292008088124	Dohne Merino	35.60	8	18.44	42	5.63	49
s5100092007070376	Dohne Merino	36.23	10	19.64	54	6.12	62
s5101402006060368	Dohne Merino	37.56	21	19.69	57	4.96	63
s5100072008083953	Dohne Merino	36.21	61	20.15	62	4.71	73
s5100072008084048	Dohne Merino	34.96	71	19.94	64	5.87	82
s5100032007070949	Dohne Merino	37.66	84	19.83	66	5.73	84
s5101462007070128	Dohne Merino	36.89	114	19.90	73	5.58	113
s5100492007071700	Dohne Merino	37.57	159	19.87	77	5.96	119
s5100732007070006	Dohne Merino	36.96	176	19.59	89	5.90	164
s5100302005050068	Dohne Merino	37.38	179	18.95	167	6.44	171
s4000302007070056	Dorper	39.01	68	19.67	76	7.66	32
s4000302007071209	Dorper	39.05	131	19.30	101	5.09	65
s4000302007070617	Dorper	36.46	162	19.22	139	6.36	75
s5023022006006580	Merino	36.41	3	18.55	2	5.66	5
s5043622006LON449	Merino	35.54	4	19.41	5	4.79	6
s5034252006060205	Merino	37.60	9	20.82	12	5.30	12
s5018852006TRIMPH	Merino	33.94	12	19.64	13	5.83	16
s5044702006060022	Merino	38.63	14	20.88	14	4.32	25
s5022512006066030	Merino	36.03	15	18.90	15	6.14	26
s5044822007070461	Merino	35.16	16	20.80	16	5.73	28
s5037892008080124	Merino	36.98	23	18.75	17	6.76	35
s5015522006060480	Merino	36.88	26	16.48	21	5.27	37
s5039462007OLY716	Merino	35.01	29	18.54	26	6.39	38
s5000482007070260	Merino	37.64	31	20.84	44	6.50	39
s5024252006023997	Merino	38.50	39	19.15	46	5.58	48
s5035642007WHI393	Merino	36.94	44	16.09	48	7.04	60
s5003182007070022	Merino	38.94	57	18.33	52	6.02	68
s50923420060C0573	Merino	39.52	66	20.52	53	4.36	69
s5047432000000503	Merino	35.11	81	19.48	61	5.66	74
s5037892007LB0753	Merino	36.21	88	22.10	68	6.36	83
s5030542004040585	Merino	38.31	90	19.97	74	5.29	86
s5007882008081290	Merino	35.32	97	18.76	75	5.65	101

s5017042007L68007	Merino	36.96	104	20.09	78	4.01	102
s5044702008080588	Merino	37.22	105	20.10	96	6.05	107
s501587200606M276	Merino	37.99	107	19.97	103	6.52	109
s5049162007070719	Merino	40.91	117	19.79	122	5.55	110
s5030702008080121	Merino	36.62	124	19.91	127	7.41	112
s5007882007071254	Merino	34.05	126	20.62	145	4.48	120
s50505020080G0856	Merino	36.86	132	20.01	149	6.28	121
s5049162008080600	Merino	38.81	135	19.67	155	5.95	127
s5046152004040024	Merino	37.04	144	18.12	162	5.67	141
s5038842008081981	Merino	38.88	146	18.38	163	6.38	142
s5030972005051737	Merino	37.67	149	21.01	169	7.59	167
s5039822006060225	Merino	37.04	152	18.95	171	5.86	176
s5000872006060096	Merino	38.75	170	22.56	173	5.48	177
s5038632006OL3626	Merino	39.22	175	20.33	181	7.06	178
s5049022005005345	Merino	39.02	180	20.07	182	6.49	181
s1640732007070364	Poll Dorset	39.22	13	20.33	33	7.06	11
s1637212007070311	Poll Dorset	39.02	17	20.07	47	6.49	29
s1600852008080021	Poll Dorset	38.65	22	19.95	55	6.48	30
s1611432007070025	Poll Dorset	38.39	28	19.92	60	6.41	34
s1635282007070182	Poll Dorset	38.27	30	19.79	69	6.34	41
s1618922006060050	Poll Dorset	38.21	34	19.61	80	6.28	47
s1612352008080608	Poll Dorset	37.97	43	19.53	88	6.21	52
s1622882007070644	Poll Dorset	37.40	70	19.50	94	6.17	55
s1600012008080010	Poll Dorset	37.30	76	19.49	95	6.07	66
s1618862008080157	Poll Dorset	37.25	80	19.32	108	5.93	76
s1629472008080219	Poll Dorset	37.20	86	19.29	112	5.91	77
s1601852007070369	Poll Dorset	37.06	91	19.29	113	5.81	91
s1614152007070440	Poll Dorset	37.00	95	19.17	125	5.67	108
s1619722009090133	Poll Dorset	36.83	111	19.10	130	5.60	116
s1611432008080203	Poll Dorset	36.77	115	19.08	131	5.58	118
s1612352007072025	Poll Dorset	36.76	116	19.07	133	5.51	124
s1622882008080077	Poll Dorset	36.69	118	19.05	136	5.42	128
s1636772007070839	Poll Dorset	36.50	123	19.05	137	5.41	129
s1636772008081037	Poll Dorset	36.43	125	19.05	138	5.40	131
s1627502008080481	Poll Dorset	36.21	136	18.99	140	5.39	132
s1623682007070468	Poll Dorset	36.13	141	18.92	147	5.22	143
s1619722006061831	Poll Dorset	35.85	150	18.87	150	5.17	148
s1640002009090052	Poll Dorset	35.77	155	18.68	158	5.09	152
s1611582007070190	Poll Dorset	35.73	157	18.47	166	5.04	157
s1603362008080541	Poll Dorset	35.22	173	18.37	170	4.57	174
s6090542006066533	Poll Merino	36.43	1	19.96	4	5.07	1
s6012442007070304	Poll Merino	35.12	19	21.31	6	5.07	10
s6013362008RAS004	Poll Merino	38.60	20	21.31	7	3.84	17
s6005712006060904	Poll Merino	38.60	24	18.78	10	6.63	20
s6008152006060120	Poll Merino	36.05	32	21.60	23	4.74	22
s6001052007071080	Poll Merino	35.81	37	20.55	25	5.91	46
s6011272007070121	Poll Merino	35.61	48	19.87	28	5.82	50
s6013072005050165	Poll Merino	39.55	56	19.87	31	5.82	58
s6010532003031078	Poll Merino	39.55	58	19.63	38	6.16	70
s6013162007070023	Poll Merino	38.03	67	19.63	39	6.71	78
s6013322004000WD2	Poll Merino	36.71	73	18.49	63	6.71	87
s6010822008081288	Poll Merino	39.72	92	19.96	70	5.17	88
s6005532007070002	Poll Merino	39.72	96	19.96	72	6.57	99

s6004082007070069	Poll Merino	36.00	101	20.35	79	5.50	100
s6013652006060052	Poll Merino	38.16	134	19.78	87	5.10	114
s6010532007071190	Poll Merino	38.16	140	19.78	92	5.62	125
s6012882006063091	Poll Merino	35.61	143	18.96	107	6.28	145
s6008802006060627	Poll Merino	35.61	145	19.51	111	5.73	155
s6012502004407812	Poll Merino	36.91	147	20.24	142	4.49	159
s6012792007070470	Poll Merino	40.02	154	22.10	154	5.74	160
s6011272008088254	Poll Merino	37.36	156	22.10	165	5.85	161
s6091542006060306	Poll Merino	35.52	164	20.19	174	5.85	168
s6091542004040062	Poll Merino	35.26	166	19.36	175	5.82	170
s6013562007000449	Poll Merino	40.93	169	20.38	176	8.04	175
s6005712006060058	Poll Merino	40.93	172	20.38	179	5.71	179
s6008152007070323	Poll Merino	38.67	182	23.66	180	7.63	182
s4800552007070068	Prime Samm	39.22	18	23.66	18	7.63	9
s4800402008080217	Prime Samm	36.18	25	20.70	22	6.88	13
s4801222008080343	Prime Samm	38.10	50	20.30	30	6.84	27
s4800872006060421	Prime Samm	37.23	64	20.26	35	6.39	36
s4801222005051010	Prime Samm	39.19	65	20.58	45	4.05	43
s4800302008080078	Prime Samm	37.54	85	18.85	84	6.06	67
s4800302008080111	Prime Samm	37.81	108	19.59	110	7.09	103
s4801042008080549	Prime Samm	38.76	127	20.09	116	6.30	140
s4800392007070062	Prime Samm	37.22	171	19.51	152	5.65	154
s4800992006060191	Prime Samm	39.69	174	18.40	156	6.00	180
s1916612008080491	Suffolk	39.69	11	18.40	51	6.00	24
s1900602008080369	Suffolk	37.97	51	18.16	58	5.78	51
s1920452007070508	Suffolk	37.72	62	19.23	90	5.17	71
s1901112007077058	Suffolk	35.97	69	19.99	100	5.04	96
s1913622007070027	Suffolk	37.48	82	19.93	102	6.53	111
s1920452008080594	Suffolk	37.40	94	18.57	120	5.61	115
s1912012008080094	Suffolk	35.80	142	18.57	161	5.70	146
s1900282007071494	Suffolk	35.80	151	19.18	168	4.80	156
s1918502001010120	Suffolk	37.86	178	21.01	172	4.80	165
s1702232004040080	Texel	37.86	47	21.01	11	6.63	21
s1704202007070224	Texel	37.73	52	20.16	41	6.48	31
s1700802007071532	Texel	37.64	54	20.01	49	6.18	54
s1702232007070046	Texel	37.50	63	19.78	71	5.90	81
s1704062007070028	Texel	36.96	100	19.26	117	5.76	98
s1700812008080039	Texel	36.82	113	18.96	144	5.32	138
s1700622007070144	Texel	35.09	177	18.62	160	5.12	151
s4701142007071345	White Dorper	37.43	7	19.25	1	6.09	4
s4701142006060036	White Dorper	36.36	41	19.42	37	5.19	15
s4700702003030011	White Dorper	37.78	42	19.41	98	6.55	23
s4701392006060057	White Dorper	36.89	46	19.14	104	5.94	53
s4702062007077118	White Dorper	37.28	60	19.03	118	5.81	72
s4701792008080386	White Dorper	37.24	78	19.56	128	5.80	90
s4700442008084825	White Dorper	38.75	129	20.12	129	5.52	144
s2300262007072446	White Suffolk	37.61	2	18.91	3	5.22	2
s2300302008080116	White Suffolk	37.89	5	18.81	24	5.14	3
s2300012008080022	White Suffolk	37.89	27	18.81	36	5.49	8
s2300342007074914	White Suffolk	36.82	53	18.50	43	5.49	14
s2303242007075630	White Suffolk	36.51	55	19.07	50	5.79	33
s2301002007070677	White Suffolk	36.22	59	19.23	81	5.79	64
s2300022008080234	White Suffolk	36.22	72	19.40	83	6.85	80

s2300992008080097	White Suffolk	36.82	74	19.44	85	6.85	85
s2303182008080262	White Suffolk	35.79	75	19.44	86	5.32	92
s2300152009090255	White Suffolk	35.79	79	19.46	99	5.84	93
s2300432007070591	White Suffolk	35.52	93	18.68	106	5.53	94
s2303242008085244	White Suffolk	37.60	99	20.56	119	5.53	97
s2300432008080136	White Suffolk	37.31	102	18.85	123	5.71	104
s2300432008080644	White Suffolk	36.31	103	18.96	132	5.16	122
s2300912007070008	White Suffolk	37.20	109	19.56	143	5.17	123
s2300152007070143	White Suffolk	37.20	110	19.99	146	7.83	126
s2300262008083813	White Suffolk	37.41	112	19.99	148	4.70	137
s2300022007070098	White Suffolk	37.41	121	20.30	151	5.80	139
s2300092007070279	White Suffolk	37.95	130	22.29	153	5.77	147
s2301132008080205	White Suffolk	35.97	138	22.29	157	7.13	149
s2301132007070040	White Suffolk	35.34	160	18.10	159	7.13	150
s2304502007071456	White Suffolk	35.34	161	18.10	164	4.99	172

Table 29.5. Correlations between the sire BLUP values for the optimal discriminant function and the BLUP values for the carcass measurements of the loin cut

	Topside	IMF	CEMA	LLFAT	HGRFAT	SHEARF5	LMY
Optimal linear Discriminant	0.48	0.24	0.14	-0.11	0.09	-0.31	0.07
IMF			0.51	0.12	0.12	-0.39	0.21
CEMA				-0.16	0.16	-0.21	0.10
LLFAT					0.08	0.19	0.02
HGRFAT						0.11	0.51
SHEARF5							0.07
LMY							

Table 30.5. Correlations between the sire BLUP values for the optimal discriminant function and the BLUP values for the carcass measurements of the Topside cut

	Loin	IMF	CEMA	LLFAT	HGRFAT	SHEARF5	LMY
Optimal linear Discriminant	0.48	0.29	-0.11	0.13	0.13	-0.43	0.26
IMF			-0.01	0.52	0.52	-0.38	0.19
CEMA				0.05	0.05	0.06	-0.39
LLFAT					1.0	-0.21	0.17
HGRFAT						-0.21	0.17
SHEARF5							-0.12
LMY							

Milestone 6

The measurements that would be made on a carcass at or about slaughter that were available were considered to be the breed, sire, sex and killing group of the animal, and the carcass weight, intra- muscular fat, shear force, pH, eye muscle area and various fat measurements. The experimental unit was now the animal, not the consumer judgements that made up 10 observations of the eating quality variables for each animal. That is, the observational unit had to be some statistic of the 10 answers for each animal. This invites consideration of a suitable statistic of the 10 answers which should be used. The mean would be a natural choice for this statistic, however as noted in previous reports the frequency distribution of the consumer judgements exhibited peculiar properties, in particular a tendency to be skewed with a disproportionate frequency of extreme judgements from some consumers. This resulted in a range of variation contributing to any summary statistic of the 10 answers.

Clipping the data by dropping observations with high residuals (greater than 5 units of overall liking residual) thus removing consumers who might be a different “population” improved estimates of the sire intra – class correlation, implying that genetic improvement should follow this strategy, although an optimal clipping strategy has not yet been defined.

Here results are presented for clipped and non - clipped data and using both the mean and the medium as the summary statistic of the 10 consumer answers. In all cases the analysis is weighted least squares where the weights are the variance estimates for each of the 10 consumer answers.

Unclipped Data

Table 1.6 shows the least squares means and standard errors for the means of each of the 10 consumer answers weighted by the variances of each of these 10 consumer answers for un – clipped data for the model:

$$Overall\ liking\ \ \mu + year + cut + sire\ breed + sire\ within\ sire\ breed\ within\ killgroup + intramuscular\ fat + shear\ force + carcass\ weight + pH18 + error \quad (1)$$

This model accounted for 61% of the variance in overall liking. The model:

$$Overall\ liking = \mu + year + cut + sire\ breed + intramuscular\ fat + shear\ force + carcass\ weight + pH\ 18 + error \quad (2)$$

This accounted for 54% of the variance of overall liking. This model was also weighted for the variance of each set of 10 consumer evaluations of overall liking.

Clipped Data

Table 2.6 gives the least squares means and standard errors for the clipped data. That is only using those observations that had an overall liking residual (Milestone report 5) with an absolute value of 5 units. This degree of clipping retained 921 observations or 41% of the observations in the unclipped data. Model (2) accounted for 73% of the variance of the clipped data.

Variance Evaluations

Partitioning the variance of the 10 consumer answers for each consumer subset of overall liking according to the model (1) was carried out as a guide to how the differences between consumer evaluations might be affected by the independent variables. Inference testing cannot use the classical tests, but does give a guide that might be followed up in the future. There appeared to be no variation response due to year and sire breed, or the variance components of Kill group. The “intra – class” correlation for sire within sire breed within Kill group was 10% - a suggestion that some sires might produce progeny with meat eating quality subject to extra variation. The topside cut is notably more variable than the loin cut, as might be expected. It also seems that as intra – muscular fat increases the consumer evaluation of the overall liking becomes more variable.

Quantile Regression

A useful tool for developing a model to improve sheep meat eating quality is Quantile Regression, which defines the functional relationships between the response and independent variables for the quantiles of the response. The quantile regression coefficients for the 0.25^{th}, 0.5^{th} and 0.75^{th} quantiles are given in Table 4.6. Note the 0.5^{th} quantile is equivalent to Median regression. Table 4 shows that the eating quality of animals in the lower (25% quantile) can be improved by concentrating on the Shear force attribute, while there are no apparent gains to be made from marginal increases in e.g. the intra – muscular fat. However, at the upper (75% quantile) marginal increases in eating quality would come from decreasing lean meat yield (negative regression coefficient), improving Shear force and a decrease in carcass weight. At the median overall liking score marginal eating quality is improved by improving intra – muscular fat. A comparison with the regression coefficients in Table 1.6 indicate that differences in intra – muscular fat on eating quality are global, i.e. due to large steps, rather than local, i.e. marginal increases, except at the median value of overall liking. Interestingly, the negative association between eating quality and lean meat yield appears less important at the lower quantiles where there may be sufficient variance to improve both attributes.

A more comprehensive quantile regression analysis would be useful in formulating industry strategy for improving sheep meat eating quality, but is outside the current remit.

Derivation of the Probability Distribution of Eating Quality Defined by the Score and the Measured Carcass Variables.

The purpose of this analysis is to derive a result for the probability that a piece of sheep meat with given attributes will be evaluated as having a particular eating quality score or star rating.

The logit analysis gives the expected multinomial probabilities conditional on the value of the linear relationships between tenderness, juiciness, flavour and the residual on overall liking presented in Table 5.6 for the loin cut. The conditional probability can be defined by taking into account the variances and covariance's of the sensory variables in Table 5.6.

The conditional probability distribution for the eating quality score given the measurements of the carcass variables intra – muscular fat and shear force is then:

$$P[EQ|IMF;SHEARF5] = P[EQ|dis] \times P[dis|IMF;SHEARF5]$$

Where $P[EQ|dis]$ = Multinomial distribution

$P[dis|IMF;SHEARF5]$ = beta distribution

This formulation can be applied to derive a conditional multinomial probability distribution for the consumer evaluated eating quality score given expected values for intra – muscular fat and shear force. A beta distribution provided a suitable fit for the frequency distribution of the logit discriminant functions given in Table 5.6.

The conditional distribution for the eating quality score given values measured for intra – muscular fat and shear force can be formed by simulation:

1. Given values for intra – muscular fat and shear force use the regression coefficients in Table 6.6 to calculate an expected value for the logit discriminant function.
2. Draw a random sample from a beta distribution associated with each logit discriminant function shown in Tale 6.6.
3. Add the random beta variable to the expected value of the logit discriminant function.
4. Calculate the probability, which is that the logit discriminant value will fall into each of the 4 eating quality classes.
5. Form a frequency distribution for the conditional frequency that a sample with the given intra – muscular fat and shear force values would be classed into each of the 4 eating quality classifications by performing steps 2 to 4 many times.

An example for an expected BLUP estimate for intra – muscular value of 3.5 and an expected BLUP estimate for shear force 5 of 43.4 is shown in Figure 2.6. There is considerable overlap in the probabilities that sheep meat from a sire with such BLUP estimates for eating quality scores of 3 and 4. This demonstrates the degree of associated uncertainty in allocating eating scores.

Application of Regression Trees to Partition of Sheep Meat Eating Quality

The consumer evaluated eating quality score or star rating did not provide a clear partition of the eating quality grades based on sensory variables and other carcass attributes. This made the allocation of eating quality grade less well defined than might be the case. Regression trees were applied to seek a better partition. Figure 1.6 shows the results of a regression tree applied to discriminate the (average of 10 samples) eating quality score based on tenderness, juiciness, flavour and overall liking. The discrimination is all based on overall liking. The histograms of the Regression Tree partitioning are also shown in Figure 1.6. There does appear to be a pattern in terms of increasing, constant and decreasing frequencies across the spans of the 4 classes, although it is not apparent that this helps very much. In terms of the optimum discrimination of forming distinct eating quality classes' examination of Figure 1 suggests that perhaps more meat from lower 3 star should be placed in 2 stars, the upper part of 3 stars should be moved to 4 stars, and the upper part of 4 stars should be moved to 5 stars.

Generally Regression Trees failed to formulate a suitably discrete partitioning of consumer evaluated eating quality score based upon any measured sensory or carcass variables. This can be seen from the histograms in Figure 1.6. It was likely that the between consumer variation noted in earlier reports induced enough variability to render this exercise redundant.

Discussion

The results reported in Milestone 5 showed that if the data was clipped by removing observations with large overall liking residuals workable sire intra – class correlations could be found. The clipping reduces the influence of consumers having different reference points for judging sensory variables and eating quality. Clipping improved the fit of the model fitted to average data effects substantially (73% of the variance for clipped; 54% of the variance for unclipped). However, clipping of data that already had individual consumer data 'averaged out' is problematic. Since only low deviations were retained (<= 5 units) for the analysis with clipped data it is to be expected that model fit in this case would be high. This issue needs further theoretical consideration.

When matching the measurements made on a carcass to the 10 separate consumer evaluations associated with each (single) carcass measurements it was necessary to deal with the considerable differences in variability of each set of 10 answers. This was done with weighted regression, using the 10 answers variances for each carcass measurement as the weights. An alternative approach using the median for each of the sensory variables and the eating quality score presented no improvement over weighted regression. The variation in the 10 answers variances in overall liking was not related to any independent variables with the possible exception of intra – muscular fat. Here higher variance in the 10 answers for overall liking was related to higher intra – muscular fat. This observation may merit further attention, especially as quantile regression indicated the eating quality response to intra – muscular fat may not be proportional.

An attempt to derive an eating quality classification with clearer boundaries was unsuccessful. The results indicate that deeper consideration is necessary, perhaps with attention to nonlinear effects such as thresholds in the consumer responses to the relationship of the sensory variables to eating quality.

Table1.6. Weighted least squares means and standard errors for overall liking average (un – clipped) of 10 consumer answers for each of the independent variables. Weights are the variances of each of the 10 consumer evaluations per carcass of overall liking

Variable		Weighted Least Squares Mean an Standard Error for Overall Liking
Year	2009	63.3 ± 0.33
	2010	60.7 ± 0.33
Cut	Loin	71.2 ± 0.33
	Topside	52.8 ± 0.33
Sire breed	Bond	63.9 ± 1.01
	Border Leicester	62.7 ± 1.25
	Coopworth	61.1 ± 1.24
	Corriedale	63.2 ± 1.23
	Dohne Merino	63.6 ± 1.26
	Dorper	60.8 ± 1.19
	Merino	62.1 ± 1.29
	Poll Dorset	58.9 ± 1.21
	Poll Merino	62.0 ± 1.29
	Prime Samm	63.2 ± 1.28
	Suffolk	62.4 ± 1.30
	Texel	60.1 ± 1.30
	White Dorper	63.6 ± 1.29
	White Suffolk	60.5 ± 1.22

Covariable	IMF	0.44 ± 0.01**
	Shear Force 5	-0.17 ± 0.001**
	Hot Carcass wt	0.06 ± 0.002**
	pH 18	0.86 ± 0.03**

Table 2.6. Weighted least squares means and standard errors for overall liking average (clipped) of 10 consumer answers for each of the independent variables. Weights are the variances of each of the 10 consumer evaluations per carcass of overall liking

Variable		Weighted Least Squares Mean an Standard Error for Overall Liking
Year	2009	63.8 ± 0.22
	2010	60.8 ± 0.20
Cut	Loin	71.5 ± 0.21
	Topside	53.1 ± 0.20
Sire breed	Bond	60.4 ± 1.98
	Border Leicester	62.8 ± 0.39
	Coopworth	62.0 ± 0.41
	Corriedale	63.0 ± 0.44
	Dohne Merino	64.2 ± 0.38
	Dorper	62.9 ± 0.78
	Merino	62.6 ± 0.37
	Poll Dorset	58.2 ± 0.24
	Poll Merino	62.1 ± 0.34
	Prime Samm	64.3 ± 0.37
	Suffolk	62.7 ± 0.41
	Texel	60.6 ± 0.41
	White Dorper	65.9 ± 0.50
	White Suffolk	60.3 ± 0.26
Covariable	IMF	0.58 ± 0.11**
	Shear Force 5	-0.21 ± 0.01**
	Hot Carcass wt	NS
	pH 18	1.89 ± 0.44**

** P < 0.01

Table 3.6. Least squares means and standard errors for overall liking median (un – clipped) of 10 consumer answers for each of the independent variables

Variable		Weighted Least Squares Mean an Standard Error for Overall Liking
Year	2009	66.6 ± 2.11
	2010	63.5 ± 2.11
Cut	Loin	76.1 ± 2.10
	Topside	54.0 ± 2.10
Sire breed	Bond	65.8 ± 4.79
	Border Leicester	65.2 ± 7.49
	Coopworth	64.1 ± 7.12
	Corriedale	66.5 ± 7.29
	Dohne Merino	66.3 ± 7.69
	Dorper	66.6 ± 4.83
	Merino	65.3 ± 9.16
	Poll Dorset	60.4 ± 10.23
	Poll Merino	64.3 ± 8.99
	Prime Samm	66.2 ± 7.99
	Suffolk	65.4 ± 7.66
	Texel	62.2 ± 7.02
	White Dorper	69.5 ± 6.91
	White Suffolk	63.1 ± 9.86
Covariable	IMF	0.73 ± 0.28
	Shear Force 5	-0.23 ± 0.03**
	Hot Carcass wt	0.16 ± 0.08
	pH 18	2.35 ± 1.05

Table 4.6. Quantile regression coefficients and standard errors for overall liking on measured carcass variables. The 50% quantile regression is equivalent to median regression

Variable	25% Quantile	50% Quantile	75% Quantile
IMF	0.52 ± 0.38	0.69 ± 0.31*	0.34 ± 0.31
Shear Force 5	-0.18 ± 0.05***	-0.12 ± 0.04**	-0.13 ± 0.04***
Hot Carcass wt	-0.27 ± 0.19	-0.40 ± 0.16**	-0.30 ± 0.15*
pH 18	2.47 ± 1.52	1.83 ± 1.26	1.66 ± 1.28
LMY	-0.21 ± 0.18	-0.34 ± 0.16	-0.31 ± 0.15*

Table 5.6. Multinomial logit estimates for calculating the probability of a meat sample with particular values of tenderness, juiciness, flavour and the residual on overall liking of being in one of the star classifications 2, 3, 4 or 5. The reference is star 2. The cut is the Loin.

Star rating	Intercept	tender	juicy	flavour	Overall liking residual
3	-4.2989 ± 0.2082	0.0310 ± 0.0032	0.0206 ± 0.0035	0.0783 ± 0.0037	0.1084 ± 0.0065
4	-12.3748 ± 0.2840	0.0667 ± 0.0039	0.0395 ± 0.0040	0.1382 ± 0.0044	0.1918 ± 0.0078
5	-25.8636 ± 0.4605	0.1155 ± 0.0053	0.0705 ± 0.0048	0.2123 ± 0.0057	0.2929 ± 0.0101

Table 6.6. Estimates for Regression coefficients for the BLUP values of IMF and SHEARF5 on the BLUP Estimates of the Logit Discriminants for the Loin, Given in Table 2.

EQ star	Intercept	IMF	SHEARF5	Alpha for beta distribution	Beta for beta distribution
3	4.94	0.107	-0.016	0.68	0.57
4	5.03	0.206	-0.030	3.21	2.69
5	2.49	0.341	-0.050	3.21	2.69

Conclusion

The prototype model developed in this project shows how sire BLUP estimates obtained for any measured carcass variables that significantly affect sheep meat eating quality can be applied to calculate a frequency distribution for each of the sheep meat eating quality scores. In this manner different frequency distributions for sires with different BLUP estimates can be calculated and compared for the proportional increases (decreases) in the frequencies of the expected eating quality performance of their progeny.