Fowler, S.M., Hoban, J.M., van de Ven, R., Gardner, G.E., Pethick, D.W. and Hopkins, D.L. (2017) The effect of lamb carcase weight and GR depth on the production of value-added cuts – A short communication. Meat Science, 131. pp. 139-141.

The effect of lamb carcase weight and GR depth on the production of value-added cuts – A short communication

Stephanie M. Fowler[a,b], Jordan M. Hoban[a,b], Remy van de Ven[a,c], Graham Gardner[a,d], David W. Pethick[a,d], David L. Hopkins[a,b]

[a]Cooperative Research Centre for Sheep Innovation, Armidale 2350, Australia

[b]NSW Department of Primary Industries, Centre for Red Meat and Sheep Development, Cowra 2794, Australia

[c]NSW Department of Primary Industries, Orange Agricultural Institute, Orange 2800, Australia

[d]Division of Vet and Biomedical Science, Murdoch University, WA 6150, Australia

Abstract

Times for the progressive breakdown of 95 lamb carcases were recorded to determine the impact of carcase weight and GR tissue depth on the time and therefore cost to produce value added retail cuts. Further analysis also assessed the potential to use these carcase traits as predictors of fabrication times. Regression modeling demonstrated there was a limited ability to predict the difference in time to fabricate *mid value-added* (R^2 = 0.18) and *extreme value-added* (R^2 = 0.12) cuts compared to traditional cuts, suggesting that other factors need to be considered. However, this study highlighted the significant increases in time required to fabricate more value-added cuts and to breakdown heavier carcases. Furthermore, this study demonstrated the changes to the saleable meat yield as the degree of fabrication increased, such that the average product prices increased ($20.64/kg for mid value added and $28.72/kg for extreme value added) compared to traditional retail cuts ($15/kg) to offset the increased labour of fabricating value-added cuts.

Keywords: Yield; Retail cuts; Carcase fabrication

1. Introduction

Unlike other meats, value-added retail lamb cuts have not been widely adopted in Australia since the development of the 'Trim lamb' cuts in the 1990's (Hopkins et al., 1995). As genetics and animal management practices have improved in the last two decades lamb carcases have become larger (Pattinson, Wilcox, Williams, & Kimbal, 2015), yet the demographics of Australian lamb consumers and their consumption patterns have changed as household size has become smaller (Australian Institute of Family Studies, 2016). Consequently, traditional lamb retail cuts, such as whole leg roasts, have become larger and therefore have less appeal to lamb consumers from smaller households.

Development of the 'Trim lamb' retail cuts included an analysis of returns for the new cuts (Hopkins et al., 1995). This was the result of industry consultation, which highlighted the need for retailers to be provided with information on the profitability of different types of cutting methods and carcases (Hopkins et al., 1995). To date, no formal investigation has been made into emerging leg and shoulder value-added cuts to determine whether there is an impact of increasing carcase weight and GR tissue depth on the time and labour required to process larger carcases into smaller cuts. Consequently, a study was conducted to determine the impact of carcase weight (CWT) and GR tissue depth on the time and cost, of fabricating value-added retail cuts versus traditional retail cuts. Therefore, this research tested the hypothesis that greater CWT and GR tissue depth increases the time, and consequently the cost, of fabricating value-added retail cuts.

2. Materials and methods

Over four consecutive days, 95 lamb carcases were progressively broken down from traditional retail cuts into *mid value-added* cuts and *extreme value-added* cuts. Cuts were prepared by experienced butchers at two different tables (1 person timing per table), with each carcase broken down by the all the butchers at one table (4 butchers per table) as standard in commercial processing plants. This study was conducted as part of a larger study to develop predictions of cut weight from estimates of lean meat yield and CWT.

The combinations of cuts which were chosen for traditional, *mid value-added* and *extreme value-added* cuts are given in Fig. 1(data for the full combinations of cuts are available upon request).

The time taken by the butchers to fabricate each cut from traditional to value-added cuts was recorded. Also recorded were day, person recording the time, CWT, GR tissue depth (on the 12th rib 110 mm from the midline of the carcase), eye muscle area (EMA; surface area of the M. *longissimus thoracis* at 12th rib measured using a square cm grid (cm^2)), sex of the lamb and weights for each individual cut. Times were converted to decimal units prior to analysis.

Firstly, times for each cut were regressed on weights of selected cuts of the carcase after adjusting for Timer × Date and CWT to determine if the weights of any of the cuts significantly influenced the time to prepare the cut after adjusting for Timer, Date and CWT.

Secondly, a multivariate linear mixed model (MLMM) regression analysis was conducted to estimate the difference in time to section the *mid value-added* and *extreme value-added* cuts within a carcase, compared with the traditional cut; and to determine if this changed with other variables, in particular CWT, EMA, GR depth and Sex which were fitted as fixed effects and interaction effects for Sex, CWT, EMA and GR depth with cuts as fixed effects and correlated residuals for cuts within independent carcase effects were fitted as random effects. Since time differences within a carcase were of interest the factors Timer, Date and Timer × Date were also fitted as fixed effects. Interaction effects for Timer, Date and Timer × Date with Cut were fitted as random effects.

All models were fitted using *asreml* (Butler, Cullis, Gilmour, & Gogel, 2009) using R core software (R Core Team, 2015). Tests for significance of fixed effects were based on Wald F statistics as developed by Kenward and Roger (1997). Marginal R^2 values were calculated for the regression on CWT for *mid* and for *extreme* differences compared with traditional as described by Nakagawa and Schielzeth (2013).

3. Results

The carcases measured in this study had a weight range of 13.0–39.5 kg (mean = 25.9, s. d. = 5.9) and a GR tissue depth of 4.5–44.0 mm (mean = 19.8, s.d. = 7.7) which is similar to the range of weights that would be expected of lamb carcases commercially processed in Australia including larger carcases. The mean time to break down carcases into traditional cuts was 13.22 min (s. e. = 0.25), while the mean time to break down carcases into value added cuts were 33.82 min (s. e. = 0.43) and 46.87 min (s. e. = 0.48) for *mid value-added* and *extreme value-added* cuts respectively.

Based on the univariate analyses for cuts, after adjusting for Timer × Date and CWT, there were significant correlations between the time taken and cut weights for the Rib Flap Boneless in the traditional carcase breakdown (P < 0.001); Eye of Shoulder for *mid value-added* cuts (P < 0.001); and Neck Trim for *extreme value-added* cuts (P = 0.01).

After adjusting for Timer × Date, CWT and those cuts weights identified as significant, none of the remaining cuts explained a significant portion of the remaining variation in the time to prepare cuts. However, after adjusting *mid value-added* cut times for the Eye of Shoulder and *extreme value-added* cut times for Neck Trim, CWT remained significant (P < 001). Yet for *traditional* cuts, after adjusting for Rib Flap Boneless, CWT was not significant (P = 0.58).

EMA, GR depth or Sex, either individually or jointly, did not remove any variation in fabrication time after adjusting for Timer × Date and CWT. However, Time was correlated with CWT and regressions on time differed significantly across cuts (P < 0.001). The estimated time to create *mid value-added* cuts increased by 0.32 min (s.e. = 0.034) (21 s) for each extra kg of carcase weight, when averaged over the two Timers × four Dates. The corresponding coefficient for CWT when predicting the estimated extra time to create the *extreme value-added* cuts compared with the traditional cuts, 0.44 min/kg (s.e. = 0.065), is significantly larger ($P < 0.05$) again. In summary, the estimated difference in times for *mid value-added* compared with *traditional*, and for *extreme value-added* compared with *traditional* were:

mid–traditional:12.1 (s.e.=3.3) + 0.315 9s.e.=0.048) CWT (marginal $R^2 = 0.08$)

extreme–traditional:21.8 (s.e.=3.5) + 0.440 (s.e.=0.065) CWT (marginal $R^2 = 0.12$)

The mean weights (kg) and standard error of carcase components for each cut fabrication method are outlined in Table 1.

4. Discussion

This study demonstrated that significantly longer times are taken by butchers to break carcases into value-added cuts compared to traditional retail cuts and the breakdown takes longer as CWT increases. It is not possible to compare the results in the current study to previous research (Hopkins et al., 1995) as Hopkins et al. (1995) measured the absolute time for carcases to be broken down in one of two ways (traditional or value added), while the current study measured the relative time to fabricate increasingly value added retail cuts from each carcase. However, this study demonstrates that preparation time of retail cuts increases as more value-added cuts are created from larger carcases. However, only marginal improvement in the prediction of the increase in time taken to prepare value-added cuts was achieved, when additional variables EMA, GR tissue depth and Sex were included. Consequently, more research is required to determine which other factors, such as tissue growth patterns and experience of butchers, contribute to the time taken.

Given that industry is looking for alternative options for larger carcases between 25 and 30 kg, it equates to a minimal difference of 1.6 min and 2.2 min respectively to prepare cuts from carcases over this heavier weight range for the two value-added options relative to the traditional cuts. Consequently, this study is informative in terms of the increase in labour requirements needed to break down heavier lamb carcases into value added cuts as the time taken to create the new cuts needs to be justified in the price returns to offset the additional preparation time and therefore, labour costs (Hopkins et al., 1995). In 1 h of labour, a butcher can break down approximately 4.5 average weight (25 kg) lamb carcases, generating 81 kg of retail cuts and trim, including bones, which equates to a $0.22/kg cost of labour based on a current average industry wage of $18 (Fair Work Ombudsman, 2016). However, when 25 kg carcases are further broken down into *mid value-added* retail cuts, a butcher can break down only 1.7 carcases in 1 h, resulting in 28 kg of product. Therefore, the average price of labour increases to $0.64/kg to create *mid value-added* retail cuts. Breaking down carcases into *extreme value-added* cuts results in 14 kg of retail cuts, as a butcher is only able to breakdown 1.2 25 kg lamb carcases in an h. Consequently, the average labour cost per kilo increases to $1.29/kg.

Furthermore, the creation of value-added retail cuts also varies the percentage of the carcase that contributes to the proportion of saleable meat, bone, fat and trim. Therefore, price returns must also account for the increase in trim, bone and fat and the reduction in saleable meat which occurs as the carcases are broken down further. At current market prices of $15/kg for saleable meat and $3.50/kg for trim (MLA, 2016) and an average carcase (25 kg) in this study, the total value of the carcase drops from $247 ($240 saleable meat, $7 trim) with traditional cuts to $193.13 with *mid value-added* cuts ($180 saleable meat, $13.13 trim) and $149.63 with *extreme value-added cuts* ($131.25 saleable meat, $18.38 trim). Consequently, to overcome the loss in saleable meat, the average price per kilo needs to be increased to $20/kg and $27.43/kg for *mid value-added* retail cuts and *extreme value-added* retail cuts, respectively.

Combining both the increased labour costs and losses due to changing percentages of saleable meat and trim, this results in an overall price increase from $15/kg for saleable meat cut into traditional retail cuts, to $20.64/kg for mid value-added retail cuts and $28.72/kg for extreme value-added cuts.

While there may be disadvantages of value-added cuts due to increased labour costs and a reduction of the weight of salable meat due to fabrication, there are several advantages to processors and retailers adopting these cuts. As with the development of trim lamb cuts, fabrication of value-added cuts will also reduce problems with high visible fat content often associated with traditional cuts from fatter carcases, as the fat content cannot be reduced proportionally compared to cuts from leaner carcases (Hopkins et al., 1995). Furthermore, smaller leg cuts such as the knuckle or a compact roast shoulder from the forequarter, will provide alternative leg roast cuts that may appeal to consumers from smaller households (2–4 people) which are increasingly common in Australia.

5. Conclusion

Overall this study demonstrated the significant increase of time taken to fabricate more value-added cuts from larger lamb carcases. However, further research is needed to determine the factors which impact on the time taken to bone out value added retail cuts. The findings from this study also demonstrated that there are increased costs associated with the creation of more value-added cuts due to increased fabrication times and changes to the proportion of saleable meat, trim, fat and bone. Consequently, processors and retailers offering these products will need to increase the cost per kilo to offset the increased costs associated with cut fabrication.

Acknowledgements

The authors would like to thank Matthew Kerr (NSW DPI) for his technical assistance during this study, Chris Smith for provision of the cut weight data, Meat and Livestock Australia for their support of the butchers who undertook the boning and the Sheep CRC for funding this study.

References

Australian Institute of Family Studies (2016). Households in Australia facts and figures. https://aifs.gov.au/facts-and-figures/households-australia.

Butler, D., Cullis, B., Gilmour, R., & Gogel, B. (2009). *ASReml-R reference manual*. Brisbane, Qld: DPI & F Publications: Department of Primary Industries and Fisheries.

Fair Work Ombudsman (2016). In Government, A (Ed.), *Pay guide - Meat industry award 2010*.

Hopkins, D., Wotton, J., Gamble, D., Atkinson, W., Slack-Smith, T., & Hall, D. (1995). Lamb carcass characteristics I. The influence of carcass weight, fatness, and sex on the weight of 'trim' and traditional retail cuts. *Australian Journal of Experimental Agriculture*, 35, 33–40.

Kenward, M. G., & Roger, J. H. (1997). Small sample inference for fixed effects from restricted maximum likelihood. *Biometrics*, 53, 983–997.

Meat and Livestock Australia (MLA) (2016). Retail beef and lamb finish 2015 on high. http://www.mla.com.au/Prices-markets/Market-news/Retail-beef-and-lamb-finish-2015-on-high.

Nakagawa, S., & Schielzeth, H. (2013). A general and simple method for obtaining R2 from generalized linear mixed-effects models. *Methods in Ecology and Evolution*, 4, 133–142.

Pattinson, R., Wilcox, C., Williams, S., & Kimbal, C. (2015). *NSW wool industry and future opportunities.* NSW Department of Primary Industries.

R Core Team (2015). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing.

Fig. 1. Flow charts illustrating the various combinations of cuts fabricated within the creation of traditional, mid value-added and extreme value-added retail lamb cuts.

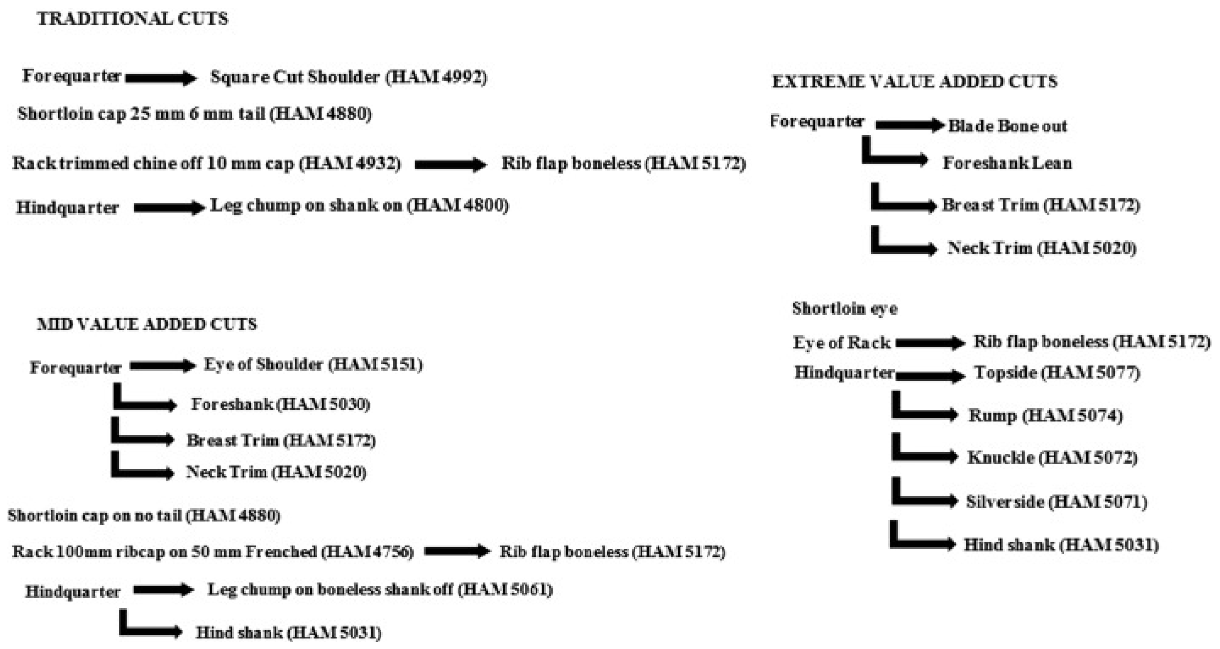

Table 1. The mean (kg) and standard error of the mean for carcase components (saleable meat, trim, fat and bone) weighed during the progressive breakdown of carcases into traditional, *mid value-added* and *extreme value-added* retail cuts.

Carcase component	Average weight fabricated per cutting method (kg ± standard error)		
	Traditional	Mid value-added	Extreme value-added
Saleable meat	16.54 (0.37)	12.54 (0.29)	9.05 (0.20)
Trim	2.13 (0.05)	3.86 (0.11)	5.51 (0.13)
Fat	1.32 (0.07)	2.20 (0.10)	4.24 (0.17)
Bone	1.95 (0.04)	4.43 (0.09)	4.41 (0.08)