Meat Science 117 (2016) 147–157

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

The impact of genetics on retail meat value in Australian lamb

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ARTICLE INFO

Article history:
Received 18 August 2015
Received in revised form 19 February 2016
Accepted 23 February 2016
Available online 26 February 2016

Keywords:
Carcass value
Muscling
Breeding values
Lean meat yield
Allometric growth

ABSTRACT

Lean (muscle), fat, and bone composition of 1554 lamb carcasses from Maternal, Merino and Terminal sired lambs was measured using computed tomography scanning. Lamb sires were diverse in their range of Australian Sheep Breeding Values for post weaning c-site eye muscle depth (PEMD) and fat depth (PFAT), and post weaning weight (PWWT). Lean value, representing predicted lean weight multiplied by retail value, was determined for lambs at the same carcass weight or the same age. At the same carcass weight, lean value was increased the most by reducing sire PFAT, followed by increasing PEMD and PWWT. However for lambs of the same age, increasing sire PWWT increased lean value the most. Terminal sired lambs, on average, had greater lean value irrespective of whether comparisons were made at the same age or weight. Lean value was greater in Merino compared to Maternal sired lambs at equal carcass weight, however the reverse was true when comparisons were made at the same age.

1. Introduction

Hot carcass weight (HCWT) and lean meat yield percentage (LMY%) are important profit drivers across the entire value chain, but especially for processors. The value of HCWT is relatively easy to understand as it represents increased volume of product per fixed cost of slaughter and fabrication of cuts. Alternatively, the financial implications of LMY% are more complex. For processors, leaner lambs require less fat trimming, resulting in less wastage and decreased processing costs (Hopkins, 1989). Furthermore, the location of lean in the carcass also influences carcass value, as the price of different cuts vary at retail. Therefore a carcass with proportionately more lean within the higher value loin cuts, will be worth more (Pethick, Ball, Banks, & Hocquette, 2011). To reflect these profit drivers, Australian processors purchase lambs on the basis of HCWT and GR tissue depth (tissue depth at the 12th rib 110 mm from the midline) to crudely reflect LMY% (Pethick et al., 2011).

To indirectly select for LMY% and HCWT, Australian lamb producers make use of Australian Sheep Breeding Values (ASBVs) for sire post-weaning weight (PWWT), c-site fat depth (PFAT) and eye muscle depth (PEMD). All three breeding values have been shown to increase HCWT (Gardner et al., 2015), with PWWT having the biggest impact producing heavier lambs at the same age, or enabling earlier slaughter at a targeted weight. Producers also utilize the carcass breeding values to indirectly select for LMY%, with a breeding value for direct selection for this trait not currently utilized in Australian lamb breeding programs. A recent study by Anderson, Williams, Pannier, Pethick and Gardner (2015b) used computed tomography (CT) to assess lamb carcass composition and revealed that when compared at the same carcass weight, the progeny of sires with increased PEMD and decreased PFAT had a greater proportion of lean in the carcass. Additionally, it was observed that the increase in lean was preferentially distributed to the saddle (mid) section of the carcass (Anderson, Williams, et al., 2015b), a finding supported by earlier studies (Gardner et al., 2010; Hall, Gilmour, Fogarty, & Holst, 2002; Hegarty et al., 2006). Sire PWWT ASBV was shown to increase the proportion of lean in the saddle region, although the effect on carcass LMY% was smaller and less consistent than that of sire PFAT and PEMD (Anderson, Williams, et al., 2015b). The combined effect of these breeding values on LMY% and distribution of lean and therefore carcass value has not been determined. When comparing lambs at the same carcass weight we would expect sire PFAT to have the greatest increase on carcass value, followed by sire PEMD and PWWT. Alternatively, when comparing lambs at the same age HCWT will be the main profit driver, hence PWWT is expected to have the biggest impact on carcass value.

Differences between sire types have also been shown to impact carcass composition (Anderson, Pannier, Pethick, & Gardner, 2015a; Anderson, Williams, et al., 2015b; Anderson, Williams, Pannier, Pethick, & Gardner, 2015c; Ponnampalam, Hopkins, Butler, Dunshea, & Warner, 2007). Terminal sired lambs have been shown to grow the fastest (Gardner et al., 2015), and when compared at the same carcass weight, they also have a greater proportion of carcass lean than Maternal and Merino sired lambs (Anderson, Williams, et al., 2015b; Ponnampalam et al., 2008). Therefore their carcass value should be higher irrespective of whether compared at the same weight or age.

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http://dx.doi.org/10.1016/j.meatsci.2016.02.037
0309-1740/

This experiment analyzes data from a large number of lamb carcasses (1554) from the Information Nucleus Flock (INF) experiment which is run by the Australian Cooperative Research Centre for Sheep Industry Innovation (Sheep CRC). Previous analyses of the lamb carcasses from this experiment have examined the impacts of genetic and non-genetic factors on carcass composition and distribution of fat, lean (muscle) and bone and are reported in Anderson, Williams, et al. (2015b) and Anderson et al. (2015c). Alternatively, this analysis expresses these changes in absolute mass and the equivalent dollar value, thus focusing on the financial implications that genetic selection for sires high in PWWT and PEMD and low in PFAT has on the value of lean in the carcass. We hypothesize that when compared at the same carcass weight, selection of lambs for increased sire PWWT and PEMD and decreased PFAT will result in a higher carcass value through an increase in LMY%, with PFAT having the greatest impact. However, when compared at the same age we hypothesize that PWWT will have the greatest impact on carcass value. Finally, we hypothesize that the carcass value of Terminal sired lambs will be greater compared to Merino and Maternal sired lambs when compared at either the same weight or the same age.

2. Materials and methods

2.1. Experimental design and slaughter details

The design of the Sheep CRC INF is described by Fogarty, Banks, van de Werf, Ball, and Gibson (2007). In brief, approximately 10,000 lambs were produced by artificial insemination of Merino or Border Leicester–Merino (BLM) dams over a 5 year period (years 2007–2011) at eight research stations (Katanning WA, Cowra NSW, Trangie NSW, Kirby NSW, Struan SA, Turretfield SA, Hamilton VIC, and Rutherglen VIC). The sire types used in the INF included: Terminal sires (Hampshire Down, Ile De France, Poll Dorset, Southdown, Suffolk, Texel, and White Suffolk), Maternal sires (Bond, Booroola Leicester, Border Leicester, Coopworth, Corriedale, Dohne Merino, East Friesian, Prime South African Meat Merino (SAAM), and White Dorper), and Merino sires (Merino and Poll Merino). The combinations of sire and dam crosses included: Merino, Maternal × Merino, Terminal × Merino and Terminal × BLM. Lambs were weaned at approximately 100 days of age, grazed under extensive conditions and supplemented with feed at times when there was limited pasture, with availability of pasture and feed varying between sites (Ponnampalam et al., 2014). All male lambs were castrated.

The lambs were divided into groups based on live weights, with each group killed separately (kill groups) targeting a hot carcass weight at slaughter of between 21 and 24 kg, irrespective of condition score. Lambs within kill groups were on average within 5 days of age of each other and within a year there was an attempt to represent all sire types in each kill group. Within each site, the aim of selection of lambs for CT was to include at least two progeny from each sire used at the site, selected across a live weight strata. At all INF sites, lambs were yarded within 48 h of slaughter, maintained off-feed for at least 6 h, and then weighed to determine pre-slaughter live weight. Lambs were then transported for 0.5–6 h via truck to one of 5 commercial abattoirs, held in lairage at the abattoir for between 1 and 12 h, and then slaughtered. All carcasses were subjected to medium voltage electrical stimulation (Pearce et al., 2010) and trimmed according to AUSMEAT standards (Anonymous, 2005) and HCWT was then measured within 40 min of slaughter. All lambs were measured and sampled for a wide range of carcass and meat quality traits (Pearce, 2009).

2.2. Computed tomography scanning

Lambs used in the CT study of composition were slaughtered and carcasses transported to either Murdoch University (Picker PQ 5000 spiral CT scanner) or the University of New England (Picker, Bavaria, Germany) for scanning within 72 h of slaughter to determine the proportions of fat, lean and bone. Lamb carcasses were divided into three sections (fore, saddle (middle) and hind): the fore section separated from the saddle by a cut between the fourth and fifth ribs; the hind section was separated from the saddle by a cut through the mid-length of the sixth lumbar vertebrae. A detailed description of the CT scanning process and calculation of carcass composition is presented in Anderson, Williams, et al. (2015b).

2.3. Data used

This experiment utilized the HCWT results obtained from an experiment described by Gardner et al. (2015) for the progeny born from 2007 to 2010. This included 7516 lambs, representing the progeny of 76 Maternal, 127 Merino and 135 Terminal sires for which breeding value data were available. The breeding values for PEMD and PFAT are based upon live ultrasound measurement at the c-site (located at the 12th rib 45 mm from the midline), and PWWT is based upon live weight, all measured at the post weaning time point (about 240 days of age).

CT scanning data was available on 1554 of the lambs from an INF experiment described by Anderson, Williams, et al. (2015b) using 7 site–year combinations where lean measurement was available within the fore, saddle, and hind sections of the carcass (Table 1). In this experiment there were a total of 23 kill groups, with the raw average age of lamb 280 days and the number of lambs within each kill group ranging from 20 to 99 lambs (Table 1). The mean weight (and range) of the lamb carcasses in this experiment was 23.3 kg (13.3–40.0 kg), with the weight (and range) of fat being 6.3 kg (2.1–15.3), lean 13.3 kg (7.4–20.8), and bone 3.8 kg (2.4–5.7) respectively. The full description of carcass weights of fat, lean and bone across the three sections are reported in Anderson, Williams, et al. (2015b). Of the 81 Maternal, 119 Merino and 144 Terminal sires in the CT experiment, 67, 109 and 143 had ASBV values for PWWT, PEMD, PFAT and Carcass Plus Index available with the mean and range of these breeding values shown in Table 2.

In both the HCWT analysis and CT analysis, a percentage of sires selected in a year were used in subsequent years to provide sire linkage between years. The ASBV values were sourced from Sheep Genetics, which is Australia's national genetic evaluation database for sheep (Brown et al., 2007). The sire breeding values and index estimates

Table 1
Average age of lambs at slaughter and number of carcasses scanned using computed tomography in each lamb kill group at each site.

Site–year	Kill group	Average age (days)	Carcasses (n)
Kirby 2007	1	235	72
	2	270	63
	3	352	96
Kirby 2008	1	269	97
	2	345	99
	3	408	99
	4	420	96
Rutherglen 2010	1	198	55
	2	254	59
Hamilton 2009	1	229	53
Struan 2010	1	260	67
	2	287	67
	3	322	27
Turretfield 2009	1	235	58
	2	262	63
	3	310	29
Katanning 2008	1	235	20
	2	242	29
	3	319	28
Katanning 2011	1	168	87
	2	238	96
	3	280	99
	4	355	95
Total	23	–	1554