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Sire carcass breeding values affect body composition in lambs — 1. Effects on lean weight and its distribution within the carcass as measured by computed tomography

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ABSTRACT

Data are obtained from computed tomography scanning of 1665 lambs at locations around Australia. Lambs were progeny of Terminal, Maternal and Merino sires with known Australian Sheep Breeding Values for post weaning c-site eye muscle depth (mm; PEMD) and fat depth (mm; PFAT), and post weaning weight (kg; PWWT). Across the 7.8 unit range of sire PEMD, carcass lean weight increased by 7.7%. This lean was distributed to the saddle section (mid-section) where lean became 3.8% heavier, with fore section lean becoming 3.5% lighter. Reducing sire PFAT across its 5.1 unit range increased carcass lean weight by 9.5%, and distributed lean to the saddle section which was 3.7% heavier. Increasing sire PWWT increased lean at some sites in some years, and on average increased saddle lean by 4% across the 24.7 unit PWWT range. Changes in lean weight and distribution due to selection for carcass breeding values will increase carcass value, particularly through increased weight of high value loin cuts.

1. Introduction

The financial value of a carcass is influenced by its lean meat yield percentage, which represents the proportion of the carcass that is lean meat (muscle). Consumer preferences in domestic and international markets drive the industry to produce meat cuts that are larger and leaner (Banks, 2002; Hall, Kelf, Fogarty, & Murray, 2000; Laville, Bouix, Sayd, & Bibé, 2004). To achieve this goal, Australian lamb producers currently select for lean meat yield percentage indirectly via three existing Australian Sheep Breeding Values (ASBVs) for post weaning weight (PWWT), c-site fat depth (PFAT) and eye muscle depth (PEMD), which are used to select for improved growth, leanness and muscling respectively. The effects of selection using these ASBVs have previously been investigated using indicators like muscle depths (Hopkins, Stanley, Martin, Ponnampalam, & van de Ven, 2007), and weights of specific cuts (Gardner et al., 2010), however have not been quantified in terms of the change in whole carcass lean composition or distribution of lean tissue between carcass regions.

Whilst there is evidence that a strong emphasis on PWWT ASBV will increase growth rate and mature size (Huisman & Brown, 2008), there is little data showing the effects of this ASBV on carcass composition. It has been shown that lambs growing at a faster rate are proportionately leaner when compared at the same weight, largely due to a correlated increase in mature weight (Bennett, Kirton, Johnson, & Carter, 1991; Butterfield, 1988). However, Hegarty, Hopkins, Farrell, Banks and Harden (2006) showed that the genetic potential for growth (or increased PWWT) did not impact significantly on the proportion of lean in the carcass. Likewise, Gardner et al. (2010) showed no effect of PWWT on carcass composition as assessed by computed tomography (CT), in spite of the increased live weight and hot carcass weight (HCWT) at slaughter.

Numerous studies have shown that selection for increased sire PEMD impacts on muscle depth at its site of measurement, the c-site (Hall, Gilmour, Fogarty, & Holst, 2002; Hegarty, Hopkins, et al., 2006). Likewise, Gardner et al. (2010) also demonstrated an increased weight of the *M. longissimus lumborum* in response to increasing PEMD, although in this case there was little impact on other muscle weights or the percentage of lean in the carcass. Alternatively, Hegarty, Hopkins, et al. (2006) showed that lambs selected for increased PEMD increased the mass and dimensions of the loin muscle and had a small increase in four different hind limb muscles, suggesting a carcass wide effect. However the latter study only utilised nine sires compared to 93 sires used in the Gardner et al. (2010) study. Hence we can expect that increasing sire PEMD will increase the proportion of carcass lean, with this effect predominantly focused in the saddle region.

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Decreasing sire PFAT ASBV has been shown to increase eye muscle depth at the c-site (Nsoso, Young, & Beatson, 2004). Gardner et al. (2010) showed that progeny of sires with low PFAT had increased weight and dimensions of muscles within the saddle (loin weight and eye muscle area) and hind (round) sections of the carcass, indicating a more widespread impact of PFAT on muscle. However in this case there was no increase in the proportion of carcass lean.

Lastly, sire type has also been shown to impact on carcass lean tissue (Ponnampalam, Hopkins, Butler, Dunshea, & Warner, 2007). When compared at the same age, Merino sired lambs had lower values for loin weight, eye muscle area and depth compared to Maternal (Border Leicester) and Terminal (Poll Dorset) sired lambs. Compared at the same weight, the Terminal sired lambs had a greater proportion of carcass lean than Maternal sired and pure Merino lambs (Ponnampalam et al., 2008). Other studies highlight the Poll Dorset and Texel cross lambs as having a higher muscle to bone ratio than Maternal (Border Leicester) or Merino sired lambs (Atkins & Thompson, 1979; Hopkins & Fogarty, 1998). On this basis it is expected that the amount of carcass lean will be higher in Terminal sired lambs when compared at the same weight.

This paper describes the association of factors such as site (research station), birth year, sex, birth type (litter size), rearing type, dam breed, and sire type on CT lean, plus the impact of genetic selection using PWWT, PFAT and PEMD ASBVs. Preliminary results of parts of this experiment have been previously published (Anderson, Williams, Pannier, Pethick, & Gardner, 2013). We hypothesised that when lambs are compared at the same carcass weight, decreasing sire PFAT will increase the weight of carcass lean, whereas increasing sire PWWT will have no effect on the weight of carcass lean. In addition we expect that increasing sire PEMD will increase the weight of lean in the saddle region but have no impact on the proportion of lean in the whole carcass. We also hypothesised that the Terminal sired lambs will have a greater proportion of carcass lean than the Maternal and Merino sired lambs.

2. Material and methods

2.1. Experimental design and slaughter details

The Australian Cooperative Research Centre (CRC) for Sheep Industry Innovation established an Information Nucleus Flock (INF) in 2007, with details of the design of the flock presented by Fogarty, Banks, van de Werf, Ball and Gibson (2007). Some of the objectives were to measure a diverse range of phenotypic traits, including CT lean and to assess the impact of genetic selection on these traits. From 2007 to 2010, approximately 6000 lambs were born and raised at one of six research sites across Australia (Katanning WA, Kirby NSW, Stuan SA, Turretfield SA, Hamilton Vic. and Rutherglen Vic), with these sites representing a broad cross-section of the sheep producing regions of Australia. These lambs were produced from Merino or Border-Leicester × Merino dams which were artificially inseminated using semen from 100 sires per year, representing the major sheep breeds used in the Australian sheep industry. Individual sires were chosen as they were representative of a full range of ASBVs for key traits within each sire type. The sire types included Terminal sires (Hampshire Down, Ile De France, Poll Dorset, Southdown, Suffolk, Texel, White Suffolk), Maternal sires (Bond, Booroola Leicester, Border Leicester, Coopworth, Corriedale, Dohne Merino, East Friesian, Prime South African Meat Merino (Prime SAAM), White Dorper), and Merino sires (Merino, Poll Merino). 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 stratum. Lambs were grazed under extensive pasture conditions and supplemented with grain, hay or pellets when pasture was limited which varied between sites (Ponnampalam et al., 2014).

2.2. Slaughter protocol

Within each year, at each of the six research stations, lambs were divided into groups based on live weights, with each group killed separately (kill groups) at a target carcass weight of 23 kg, with a total of 1665 lambs slaughtered. 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. Across the 9 site-year combinations in this experiment there was a total of 25 kill groups, with the average age within a slaughter groups ranging from 168 to 420 days of age and the number of lambs within each kill group ranging from 20 to 99 lambs (Table 1).

At all INF sites, lambs were yarded within 48 h before slaughter, maintained off-feed for at least 6 h, and then weighed to determine pre-slaughter live weight. They 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 electrically stimulated 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, meat and growth traits.

2.3. Computed tomography scanning

Carcasses were transported for CT scanning to either Murdoch University (Picker PQ 5000 spiral CT scanner) or the University of New England (Picker, Bavaria, Germany) within 72 h of slaughter to determine the proportions of fat, lean and bone. Prior to scanning the carcasses were split into three primal components to enable more rapid post-scanning processing of the CT images for the distribution analysis: fore-section, saddle and hind section. The fore section was 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. In both cases the spiral abdomen protocol was selected with settings: pilot scan length of 512 mm, field of view set at 480 mm, Index 20, kV 110, mA 150, revs 40, pitch 1.5 and standard algorithm. At Murdoch University, the carcasses were scanned in 10 mm slice widths, with each slice taken 10 mm

Table 1
Total number of lambs scanned using computed tomography at each site.

Site-birth year	Kill group number	Average age at slaughter (days)	Number of lambs
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 2007	1	177	59
	2	248	52
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	25	–	1665