final report

Project code: B.SCC.0180

Prepared by: Emma Babiszewski & Janelle Hocking Edwards

SARDI Livestock & Farming Systems

Date published: September 2014

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

Lean meat yield and eating quality producer demonstration sites – South Australian and Tasmanian carcase measurement

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Abstract

Three Producer Demonstration Sites were undertaken in each of South Australia and Tasmania, to demonstrate the value of research breeding values for lean meat yield, intramuscular fat and shear force in prime lamb and Merino production systems.

Data was collected at slaughter from 527 Tasmanian lambs, over five slaughter events at either JBS Longford or JBS Devonport. Likewise, data was collected from 440 lambs from South Australian sites over five slaughter events at Thomas Foods International, Murray Bridge, JBS, Bordertown and Frewstal, Stawell.

Lean meat yield was calculated by measuring hot carcase weight (kg), GRfat (mm), Cfat (mm) and eye muscle area. Objective measures of eating quality were assessed by measuring fresh colour, ultimate pH, and shear force of the loin. Samples were collected and transported to the University of New England, Armidale, for intramuscular fat measurement.

Data collected from these PDS will be aggregated with data from other sites and analysed under the national coordination project, B.SCC.0144, to determine the value of research breeding values for lean meat yield and eating quality traits to ram breeders, lamb producers and processors.

Executive summary

This project is providing data to the MLA project B.SCC.0144 - Proof of Concept of Lean Meat Yield and Eating Quality Producer Demonstration Sites. The overarching purpose of these projects is to deliver “proof of concept” for lean meat, eating quality and human health attributes within major lamb and sheep meat supply chains by facilitating, empowering and developing a common focus and normal trading mechanisms on these future key industry profit drivers right along the supply chain.

Twenty Producer Demonstration Sites were established to demonstrate the impact new research breeding values (RBVs) for lean meat yield (LMY) and eating quality (EQ), particularly intramuscular fat (IMF) and shear force (SF5), will have on lamb production along the supply chain. Three of these sites were in South Australia, and three were in Tasmania.

Of the three South Australian sites, PD06 and PD19 produced sufficient lambs to meet the target of 20-25 lambs per sire for LMY measures and 10 lambs per sire for EQ measures, with the exception of one sire from PD19 who only had 9 lambs available for EQ measurement. PD05 had poor conception rates across all sires and only finished 71 lambs, 70 of which were sampled for eating quality. South Australian lambs were processed at three processing plants and over five slaughter dates and went into five supply chains.

Two of the Tasmanian sites – PD14 and PD16 – finished sufficient lambs to meet the targets for both LMY and EQ analysis, with the exception of one sire used at PD16 which only had 12 lambs at finishing due to poor conception, five of which were sampled for EQ due to a drafting error prior to slaughter. The third Tasmanian site – PD15 – also had poor conception rates across all sires which resulted in only one sire meeting the LMY target of 20 – 25 lambs. Despite this, only one sire didn’t meet the target of 10 lambs for EQ analysis. Tasmanian lambs were processed at two plants over five slaughter dates and went into two supply chains.

Shear force samples were processed at Struan Research Centre within five weeks of the final slaughter for each site, with SF5 means varying considerably between sites. IMF samples were transported from Adelaide to Armidale by same day delivery air freight, for processing at the University of New England (UNE).

Data collected from these PDS will be aggregated and analysed in project B.SCC.0144 to determine the value of RBVs for LMY and eating quality traits to ram breeders, lamb producers and processors.

Table of Contents

1. Background

The aim of this project is to deliver “proof of concept” for lean meat yield, eating quality and human health attributes within major lamb and sheep meat supply chains by facilitating, empowering and developing a common focus and normal trading mechanisms on these future key industry profit drivers right along the supply chain. From the Sheep Genomics Program and the Information Nucleus Flock of the Sheep CRC, Poll Dorset, White Suffolk and Merino sires have been identified that have significant differences in RBVs for dressing percent, LMY and eating quality, particularly IMF and SF5. Proof of concept Producer Demonstration Sites were established to demonstrate the impact these new RBVs will have on lamb production along the supply chain.

Twenty Producer Demonstration Sites (PDS) were established across Australia involving eight sires per site, with the target of producing 200 lambs for measurement & processing and allowing 80 lambs for eating quality determination. The PDS are aligned to collaborating supply chains / lamb processors (WAMMCO, JBS Australia, Thomas Food International, Woolworths, Coles & others).

This project underpins the delivery of the “Proof of Concept” through high quality sampling and measurement of lamb carcases from LMY and EQ Producer Demonstration Sites (PDS). This project encompasses the slaughter, data collection, sample delivery, storage and shear force measurement of the three PDS located in South Australia and the three PDS located in Tasmania.

The data from this project will be aggregated for analysis, validation of the RBVs and used in communications programs with Sheep Genetics, MLA and the Sheep CRC. The data will contribute to the overall outcomes of the LMY & EQ Proof of Concept project (B.SCC.0144), which include:

1. Determining the value of 6 or more new research breeding values for ram breeders, lamb producers & processors at 20-30 sites.
2. Developing suitable measurement technology and feedback mechanism for these breeding values at processing.
3. Initiating a common focus and foster the development of normal trading mechanisms including potential Value Based Trading on these future key industry profit drivers right along the supply chain.

2. Project objectives

By 31 August 2014:

1. Coordinated slaughter and abattoir data and sample collection.
2. Collected carcase measurements on up to 200 lambs per site.
3. Collected, processed and stored lamb loin samples for IMF and Shear Force (5 days aged) measurement on up to ten progeny per sire per site (up to 80 lambs per site).
4. Shipped samples for IMF testing to UNE, Armidale NSW, within three weeks of the final slaughter at each site

5. Conducted measurement of Shear Force at day 5 within six weeks of the final slaughter group from each site.
6. Submitted all data in the standard data template to the LM&EQ PDS National Coordinator within six weeks of the final slaughter group from each site.

3. Methodology

3.1 Coordinated slaughter and abattoir data and sample collection

Measurements were collected over two slaughter dates for demonstration sites PD05, PD06, PD14 and PD16, while PD15 and PD19 had only one slaughter date (Table 1). A load of 117 PD19 lambs was delivered to Thomas Foods International (TFI), Murray Bridge, on 6th May 2014, scheduled to be killed in the afternoon of the 7th May. Prior to the arrival of the measurement team, notice was given to the team by TFI that the lambs had been slaughtered on delivery to the plant in the evening of the 6 May. Unfortunately, no data could be recovered from the slaughtered lambs.

Table 1. Slaughter date, plant location, market, number of lambs delivered and sample collection for SF5 and IMF (EQ) from PD05, PD06, PD14, PD15, PD16 & PD19.

	Date	Location	Supply Chain	N	EQ
PD05	30 Aug 2013	Murray Bridge	Woolworths	53	Yes
	23 Sept 2013	Murray Bridge	Woolworths	18	Yes
PD06	27 Nov 2013	Bordertown	JBS	126	Yes
	22 Jan 2014	Bordertown	JBS	79	No
PD14	6 Feb 2014	Longford	JBS	100	Yes
	10 Feb 2014	Devonport	JBS	100	No
PD15	14 May 2014	Longford	JBS	132	Yes
PD16	5 Feb 2014	Longford	JBS	99	No
	11 Feb 2014	Devonport	JBS	96	Yes
PD19	6 May 2014	Murray Bridge	TFI	117	No
	23 July 2014	Stawell	Domestic	112	Yes
	23 July 2014	Stawell	Export	52	No

Carcase and eating quality measurements were undertaken in accordance with those developed by the Sheep CRC (Pearce 2009).

Hot carcase weight (HCWT), GR depth, cfat thickness, and eye muscle area (EMA) at the 12th rib were measured to calculate LMY. HCWT and works fat score and/or works GR fat was provided by the processing plant. GR fat (mm) was measured with a GR knife 4-6h post-mortem at the 12th rib, 110mm from the spinal column on the right-hand side of the carcass. At approximately 20h post-mortem, pH levels were recorded in the left *m. longissimus thoracic et lumborum* (LL) at the 13th rib and in the *m. semitendinosus* (ST) as an estimate of ultimate pH.

Figure 1. PD14 carcases awaiting measurements at JBS Swift, Devonport.

Figure 2. A PD06 carcase split between the 12th and 13th ribs to allow colour and eye muscle area measurements on the exposed surface of the LL. A 13cm section of LL has been removed from the left side for EQ samples.

Carcases were cut between the 12th and 13th ribs approximately 20 hours after slaughter to expose a cross-section of LL (Figure 2). Eye muscle width (EMW; mm), eye muscle depth (EMD; mm) and cFat (mm) were measured with digital calipers (Kincrome, K11100) on the exposed surface of the LL. EMA was calculated from EMW and EMD according to the equation:

$$EMA = EMW*EMD*0.008.$$

Fresh eye muscle colour was measured approximately 21 hours post-mortem on the exposed section of LL that was allowed to 'bloom' for 30-60 minutes. A Minolta Chromameter was used to measure lightness (*L**), redness (*a**) and yellowness (*b**).

Pre-slaughter weights (kg) were collected on-farm after 1 – 23h curfew time prior to transport to the abattoir. Pre-slaughter weights were compared to HCWT (kg) at slaughter to calculate dressing percent (DP).

3.2 Collected, processed and stored lamb loin samples for IMF and Shear Force (5 days aged) measurement on up to ten progeny per sire per site (up to 80 lambs per site)

At approximately 21h post-mortem, 13cm of the left section of the LL was removed from above the 12th rib (Figure 2). From this section of LL, the fat and epimysim were removed and SF5 (65g) and IMF (40g) samples were collected. IMF samples were frozen immediately after collection, and stored at -20°C. The weight of the frozen IMF samples was recorded.

The SF5 samples were vacuum packed and aged at 4-5ºC for five days prior to freezing at -20ºC. PD06 carcases were not electrically stimulated, therefore the SF5 samples were aged at 4-5 ºC for 12 days before storing at -20 ºC .

Frozen SF5 samples were placed into a water bath at 71°C for 35min to cook, and then immersed in chilled water prior to processing. The samples were processed according to the methods of Hopkins and Thompson (2001) and a Lloyd LRX machine was used to measure 5-6 1cm^3 sub-samples from each 65g LL sample. Shear force results are presented using the SI unit of force - Newtons (N) - rather than the non SI unit - kgF.

4. Results and discussion

4.1 Collected carcase measurements on up to 200 lambs per site

Due to poor conception, none of the sires used at PD05 had sufficient progeny to meet the target of 20-25 lambs/sire for LMY measures, and only three sires met the target of ten lambs/sire for EQ (SF5 and IMF) measures. Seven sires at PD06 had sufficient progeny to meet the target for LMY, with one sire having 15 lambs due to low conception. All PD06 sires had 10 progeny sampled for EQ analysis. All sires from PD14 had sufficient progeny to meet the target for LMY and for EQ, as did all sires from PD16, with the exception of one sire that only had 12 lambs due to low conception. This sire only had 5 lambs sampled for EQ measurement due to mis-drafting of lambs prior to slaughter. Ten lambs for EQ sampling were planned to be sent to be processed on 11 February, however seven of these lambs were killed on 5 February when IMF and SF5 samples were not collected. At PD15 only one sire had more than 20 lambs available for carcase measurement due to low conception rates at this site, and seven sires met the target for EQ. PD19 had at least 20 lambs available for carcase measurement from five of the eight sires, and met the target for EQ in seven sires. The remaining sires had insufficient lambs due to the balance being unmeasured in the first draft of lambs (Table 2).

One PD05 carcase had forequarter contamination and the entire rib cage and spine were removed, which resulted in an incomplete dataset, with the exception of works fat score. Two carcases from PD06 had excessive trim, so HCWT was not recorded for these carcases, and 14 lambs did not reach target carcase weight and so did not have complete measurements recorded. One PD14 carcase was dropped during processing (after HCWT recorded) and needed to be superficially trimmed, thereby affecting fat measurement and a second lamb had pleurisy resulting in rib trim affecting eye muscle dimensions, reducing the number of carcases with full measurements. Fifty-two carcases from PD19 were destined for the export market and loaded out shortly after slaughter, allowing enough time to collect HCWT, WKSFAT, and GRfat only, resulting in an incomplete dataset for these lambs.

Table 2. Number of progeny slaughtered from each ram from PD05, PD06, PD14, PD15, PD16 & PD19.

Sire	*PD05*		*PD06*		*PD14*		*PD15*		*PD16*		*PD19*	
	Carcase	EQ	Carcase	EQ	Carcase	EQ	Carcase	EQ	Carcase	EQ	Carcase	EQ
Sire 1	5	5	24	10	30	10	23	11	34	10	28	9
Sire 2	12	12	25	10	24	10	19	10	12	5	15	10
Sire 3	9	9	25	10	25	11	19	10	20	10	12	10
Sire 4	7	7	32	12	20	10	18	10	26	11	23	10
Sire 5	8	8	30	10	25	10	10	10	22	11	24	10
Sire 6	6	6	27	11	30	10	9	9	26	10	23	10
Sire 7	12	11	25	10	22	10	16	10	25	11	20	10
Sire 8	11	11	15	10	23	10	18	10	26	10	19	11
UK	1	1	2	-	1	-	-	-	4	2	-	-
Total	**71**	**70**	**205**	**83**	**200**	**81**	**132**	**80**	**195**	**80**	**164**	**80**

As would be expected, there is a range both between and within PDS in the carcase measurements (Table 3).

Pre-slaughter liveweight of one PD05 lamb, two PD06 lambs, five PD14 lambs, four PD16 lambs and one PD19 lamb was not recorded; therefore dressing percent was calculated on a reduced number of lambs (Table 3).

Table 3. Simple statistics for HCWT, WKSFAT score or WorksGR, GR depth, CFAT, EMD, EMW, EMA, LMY and dressing percent (DP) of PD05, PD06, PD14, PD15, PD16 and PD19 lambs.

Variable	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
	PD05					**PD06**				
HCWT (kg)	70	21.9	2.63	16.8	30.2	203	22.7	2.24	18.6	29.3
WKSFAT	71	12	3.0	10	20	204	15	2.2	10	20
WKSGR (mm)										
HGRFAT (mm)	70	12.3	4.47	3.5	24.0	205	11.2	4.03	3.0	24.5
CCFAT (mm)	70	3.3	1.62	1.1	8.8	191	2.8	1.54	0.5	8.5
CEMW (mm)	70	64.2	3.63	54.5	72.1	191	62.7	4.80	26.8	71.8
CEMD (mm)	70	32.1	3.40	25.0	40.9	191	29.6	2.83	21.7	39.2
CEMA (mm^2)	70	16.5	2.23	12.4	22.6	191	14.9	2.01	6.6	22.0
LMY (%)	70	58.9	1.85	53.7	62.5	190	58.8	1.83	53.7	62.1
DP (%)	69	49.2	2.30	45.1	55.1	201	45.2	2.56	37.6	54.5
	PD14					**PD15**				
HCWT (kg)	200	24.1	2.12	18.8	30.0	132	22.6	1.81	18.6	27.9

WKSFAT	200	17	2.9	5	20					
WKSGR (mm)						132	3	0.4	2	4
HGRFAT (mm)	199	13.8	3.00	5.5	23.5	132	11.3	3.08	5.5	21.5
CCFAT (mm)	198	4.6	1.81	0.9	11.4	132	3.6	1.48	1.0	8.2
CEMW (mm)	199	63.9	3.79	32.2	74.2	132	66.1	3.54	58.1	76.5
CEMD (mm)	199	33.3	2.80	27.1	42.0	132	31.8	2.70	26.7	39.7
CEMA (mm^2)	199	17.0	1.92	8.5	24.9	132	16.8	1.90	13.2	24.1
LMY (%)	198	58.1	1.42	53.5	61.2	132	59.3	1.50	54.3	61.8
DP (%)	193	49.5	2.61	42.2	56.2	132	44.7	1.63	40.4	50.0
	PD16					**PD19**				
HCWT (kg)	195	22.1	1.70	18.6	28.6	164	19.0	2.62	12.9	26.1
WKSFAT	195	15	3.3	10	20					
WKSGR (mm)						164	2	0.5	1	3
HGRFAT (mm)	195	11.4	2.90	5.5	21.0	164	8.0	3.32	2.5	18.5
CCFAT (mm)	195	3.5	1.50	0.9	11.2	112	2.4	1.24	0.6	6.9
CEMW (mm)	195	63.8	3.35	53.7	72.3	112	61.8	3.53	52.3	77.0
CEMD (mm)	195	30.6	2.80	24.0	38.9	112	26.5	2.49	20.5	33.1
CEMA (mm^2)	195	15.6	1.77	10.3	21.3	112	13.2	1.68	8.6	18.7
LMY (%)	195	58.9	1.40	54.5	62.5	112	59.4	1.42	55.0	62.5
DP (%)	191	46.2	2.36	41.0	59.1	163	44.7	2.27	37.8	51.2

Fresh colour measurements of the loin were within normal range across all sites (Table 4). Ultimate pH (pHu) of the LL from PD05, 14, 15 & 16 carcases were acceptable, with all carcases from PD15 less than pH6.0. A very small proportion of carcases had pHu greater than 6.0 (PD05=3; PD14=4; PD16=2; PD19=6). The pHu of the LL from the PD06 lambs was higher, but a lower proportion of carcases were classed as dark cutting (N=4). Average pHu of the ST muscle of PD05 and PD06 lambs was also high, but similar to levels seen in the INF. The pHu of the LL and the ST of the Merino lambs (PD19) was higher than the terminal sired lambs. Average pH of the ST muscle was higher than the loin at all sites as would be expected.

Table 4. Simple statistics for loin colour (lightness, *L**; redness, *a**; brightness, *b**), ultimate pH of the LL and ST of PD05, PD06, PD14, PD15, PD16 and PD19 lambs.

	PD05					PD06				
Variable	**N**	**Mean**	**SD**	**Min**	**Max**	**N**	**Mean**	**SD**	**Min**	**Max**
Lightness (L*)	71	35.35	2.33	28.50	40.70	148	33.4	3.12	26.5	41.0
Redness (a*)	71	18.70	1.24	15.20	21.40	148	19.1	2.01	14.3	24.7
Brightness (b*)	71	1.49	1.24	-1.40	5.00	148	1.0	0.96	-1.3	5.8
pHLL	71	5.59	0.13	5.43	6.25	162	5.83	0.10	5.60	6.16
pHST	71	6.04	0.28	5.45	6.71	162	6.10	0.24	5.67	6.71
	PD14					**PD15**				
Lightness (L*)	199	34.3	2.38	29.0	41.3	132	32.0	2.64	27.1	38.6
Redness (a*)	199	19.2	2.43	12.1	25.4	132	19.4	1.68	15.7	24.1
Brightness (b*)	199	3.6	1.35	0.5	7.6	132	2.3	1.32	-0.7	5.8
pHLL	200	5.62	0.14	5.39	6.26	132	5.65	0.08	5.45	5.90
pHST	200	5.86	0.21	5.48	6.53	132	5.75	0.13	5.52	6.25
	PD16					**PD19**				
Lightness (L*)	194	34.6	2.56	24.4	41.4	112	31.4	3.0	21.2	40.8
Redness (a*)	194	18.1	2.37	11.6	23.3	112	18.6	1.6	12.5	22.8
Brightness (b*)	194	2.4	1.81	-2.4	6.0	112	2.0	1.2	-1.2	4.4
pHLL	194	5.60	0.14	5.34	6.17	112	5.80	0.10	5.65	6.13
pHST	195	5.79	0.17	5.53	6.48	109	5.92	0.21	5.58	6.56

Although not part of the suite of contracted measurements, pH decline was measured as a service to each of the plants. The pH declines were acceptable at only 4 out of the 10 kills (<70% of carcases passing through the pH temp window; Table 5). If the maximum temperature cut-off is removed, 5 plants had acceptable

pH declines. As would be expected from the PD06 carcases that were not electrically stimulated, only a single carcase was below pH 6.0 at 13°C in the first kill and only 10% (n=3) carcases had a pH <6.0 at 13°C in the second kill. It is likely that the remaining three kills did not have an acceptable number of carcases passing through the pH-temp window due to very rapid temperature declines in the chiller.

Table 5. Number of carcases used to determine pH decline, proportion of carcases <pH6 between 18&35°C (In window) and proportion of carcases with <pH6 at 18°C (no max temp).

PDS (Kill N)	N carcases	In window	In window (no max temp)
PD05 (K1)	17	41%	41%
PD05 (K2)	35	89%	97%
PD06 (K1)	22	5%	5%
PD06 (K2)	28	11%	11%
PD14 (K1)	20	55%	55%
PD14 (K2)	21	76%	95%
PD15	21	71%	71%
PD16 (K1)	18	78%	94%
PD16 (K2)	24	67%	83%
PD19	21	5%	5%

4.2 Conducted measurement of Shear Force at day 5 within six weeks of the final slaughter group from each site.

Shear force measurements were all completed within six weeks of the final slaughter group from each site. SF5 samples from PD05 were allocated to one of two samples dates – 29th October and 31st October, 2013, five weeks after the final slaughter for this site. EQ samples from PD06 were all collected in the first kill, and as such SF5 samples were processed on the 12th and 17th December, 2013, prior to the final slaughter on 22nd January, 2014. PD14 and PD16 samples were combined and allocated to one of four sample dates 25th, 26th, 27th or 28th February, 2014; two to three weeks after the final kills for these sites. PD15 samples were processed two weeks after the only kill, on either the 27th or 29th May, 2014. PD19 SF5 samples were collected on 24th June and processed on either 24th or 25th July, 2014.

PD05 lambs had the lowest mean shear force at 34.0N with 75% of samples falling under 40N, which was comparable to the results of PD14 (39.3N) and PD16 (35.6N) with these sites achieving 70% and 79% samples <40N respectively (Table 6). In comparison, PD06 lambs had a higher mean SF5 and achieved only 17% (N=14) samples <40N, despite extended aging to compensate for the absence of electrical stimulation. PD15 also had higher mean SF5 and only 31% (N=25) samples below 40N.

Table 6. Date of measurement and simple statistics shear force (N) of PD05, PD06, PD14, PD15, PD16 and PD19 lambs.

Site	***Measurement date***	***N***	***Mean***	***SD***	***Min***	***Max***
PD05	29/10/13; 31/10/13	70	34.0	8.3	18.9	57.8
PD06	12/12/13; 17/12/13	83	53.4	13.7	28.4	92.9
PD14	25/2 – 28/2/14	81	39.3	9.6	24.8	83.2
PD15	27/5/14; 29/5/14	80	49.5	14.7	22.4	85.2
PD16	25/2 – 28/2/14	80	35.6	9.1	24.4	84.3
PD19	24/7/14; 25/7/14	80	83.1	19.3	37.0	132.0

The shear force of the Merino lambs (PD19) was extremely high, with only two of the 80 samples falling below 40N (Table 6). The Research Officer who undertook the measurements commented that the samples were "tougher" to prepare for measurement, supporting the significantly high results. These lambs were graded into light export and domestic based on a carcase weight placed into different chillers. The domestic chiller contained only the PD19 lambs for 4-5 hours, before other carcases were added, therefore the temperature of the chiller was very cold. A subsample of lambs were measured for pH temp decline and 4 hours after entering the chiller, carcases had an average temperature of 11°C and average of 6.40pH (Table 5). This may have contributed to the very high SF5 measurement. The values seem to indicate that the electrical stimulation was ineffective.

4.3 Shipped samples for IMF testing to UNE, Armidale NSW, within three weeks of the final slaughter at each site

IMF samples were transported to University of New England, Armidale for analysis in two batches for the six PDS' to economise freight costs. The first batch of 314 samples from PD05, 06, 14 and 16 was sent on 11th April, and the second batch of 160 samples from PD15 and 19 was sent on 9th July. Both batches of samples travelled from Naracoorte to Adelaide by car in a temperature controlled Engel at -5°C, after which they were packed into fully sealed Styrofoam shipping boxes, encased in long-life ice-bricks. The samples were then transported by air from Adelaide to Armidale via Sydney for same day delivery, and in both cases were collected by UNE staff from Armidale airport within 7-8h of delivery in Adelaide.

4.4 Submitted all data in the standard data template to the LM&EQ PDS National Coordinator within six weeks of the final slaughter group from each site.

All data has been collected and submitted to the National Coordinator for analysis in B.SCC.0144.

5. Acknowledgments

Sincere thanks to all staff at each of the processing plants involved. In particular, we acknowledge the assistance of plant managers Paul Whiteman (JBS Longford), Michael Farrelly (JBS Devonport), Trevor Schiller (JBS Bordertown), Peter Hancock (TFI Murray Bridge) and Greg Nicholls (Frewstal, Stawell). Additional thanks to Mark Inglis, Dave Rutley and Melissa Neal for assistance in the coordination of slaughter events.

We recognise the contributions of Leanne Sherriff, Mandy Allen, Jason Lynch, Matt Sheather, Jono Barnes, Andrew and Scott Colvin for assistance with data collection in Tasmania, as well as Elke Hocking, Nat Gibbs, Rachael Withers and Lachie Stewart for assistance with data collection in SA.

Sincere thanks site hosts, Graham and Karen Clothier, (Greenvale, Woolumbool). Peter and Elke Hocking (II & PE Hocking; Scottglade), Lachie and Amanda Stewart (Cherrita Pastoral, Keilira), Scott and Andrew Colvin (*Nosswick*, Blackwood Creek), Greg Sheather and Jonathon Barnes (*Wesley Dale*, Chudleigh) and Emma Boon and Jamie Downie (*Dungrove*, Bothwell).

6. Bibliography

Hopkins, D. L. &Thompson, J. M. (2001).The relationship between tenderness, proteolysis, muscle contraction and dissociation of actomyosin. Vol. 57, 1 – 12

Pearce, K. L. (2009).Sheep CRC program 3: Next generation meat quality project 3.1.1 phenotyping the information nucleus flocks: Operational protocol series., Vol. 1, pp 107 Perth, Western Australia: Murdoch University.