Using ASBVs - What's in it for me?

A review of the literature on the use of genetic technologies for the selection of dams and sires in sheep breeding programs

SHEEP CRC

Prepared by

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INTRODUCTION

The Cooperative Research Centre for Sheep Industry Innovation (Sheep CRC) has established a wide range of initiatives that are facilitating greater uptake of sheep genetic technologies. This publication is one such initiative. Its objective is to collate the results from previous research projects and producer demonstrations to build a body of evidence that will allow industry to consider the adoption of breeding values (in particular, Australian Sheep Breeding Values) and associated technologies. This reference will be extended as more information becomes available.

The projects summarised in this review were identified by the collective knowledge of the Sheep CRC Genetics Training Initiative Steering Committee. Industry experts located in all states of Australia (see list of acknowledgements) were consulted to identify relevant material. In addition the Livestock Library (www.livestocklibrary.com.au) and the MLA Producer Initiated Research and Demonstration (PIRD) database have been searched to identify further areas of work.

The benefits of using breeding values and other technologies are often put forward but the proof to support these statements has been scattered far and wide. This document is a chance to collate all the material, developed over the years, that demonstrates the outcomes from using these technologies. The review ensures that this very valuable material is not lost and that its collective impact can be appreciated.

This review is comprehensive with projects and demonstrations included regardless of their findings. Overwhelmingly the combined outcomes from the work reviewed offer a vast and compelling story of considerable benefit from the use of breeding values and associated technologies.

A number of projects summarised in this review highlight the genetic difference between individual sheep or bloodlines. These projects have been included to describe the large genetic variation that exists in the sheep industries. Tools that enable the exploitation of these genetic differences have great value when striving to maximise genetic progress and the future viability of sheep enterprises.

The scope of this review was to collate evidence rather than delve into interpretation of results. As such, much of the content has been reproduced from cited references. Collating the evidence has been the highest priority for this work and as a result the format for the material is largely as provided in the references cited.

This review clearly establishes that breeding values and associated technologies deliver genetic progress to the sheep industries. They are a vital element for sheep enterprises aiming to maximise productivity and profitability.

ACKNOWLEDGEMENTS

Genetics Training Initiative Steering Committee

- Lu Hogan – CRC Project 5.2 and overall coordinator
- Mark Ferguson – CRC Project 1.1
- Sam Gill – Sheep Genetics
- Geoff Lindon – AWI
- Richard Apps – MLA
- Allan Casey – I&I NSW (representing all state agencies)
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- Lyndon Kubeil, DPI Vic
- Gerald Martin, MLA PIRD Coordinator
- Martin Dunstan, DPI Vic
- Andrew Greenwood, Words and Letters
- Dave Hopkins, NSW DPI
- Graham Gardner, Murdoch University
- Julius van der Werf, UNE

The reference document cites a great number of papers from a range of journals. Where permission has been given from the journal or the authors, the papers have been provided as attachments to this document. When using these papers it's important that users of the information cite the definitive 'journal' source in their new publication. We are grateful to the Association for the Advancement of Animal Breeding and Genetics, Commonwealth Scientific and Industrial Research Organisation, Kondinin Group, the Australian Sheep Veterinary Society, the Australian Society of Animal Production and the many authors who have given permission to reproduce their papers in order to build this body of evidence.

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REFERENCE SUMMARY

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	MEAT AND MATERNAL		
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2	Selection of High and Low Growth Rams - Rod Peart	2003	WT
3	Project Hi-Low - PIRD	1998	WT
4	Accelerator Breeding Producer Group PIRD	2003	INDEX
5	White Suffolk PIRD Trial	2004	WT, EMD, INDEX
6	Uralba Stud Cleve – On Farm Index Comparison Trial	1998	INDEX
7	Maternal Central Progeny Test	2005	CARCASE + WOOL+REPRO
8	Value of LAMBPLAN's Muscle EBVs – PIRD	2001	WT, CARCASE
9	First X Lamb Production in Fine Wool Merino Flocks	2005	WT
10	South West Prime Lamb Group - Comparison of High & low EBV Sires	2007	WT
11	Kangaroo Island Prime Lamb Evaluation Trial	1999	WT
12	Woolsthorpe Prime Lamb Group PIRD	1996	INDEX
13	NSW DPI LAMBPLAN Trial	1999	WT
14	Effects of Nutrition and EBVs for Growth and Muscling on the Development of Crossbred Lambs	2002	CARCASE
15	Terminal/Paternal Central Progeny Test	1999	WT, CARCASE
16	Meta-Analysis of Cross-Bred Progeny Data for Australian Terminal Sire Sheep	2009	CARCASE
17	Establishment of Performance Testing for Meatsheep	1986	WT, FAT
18	Barwon Prime Lamb Group PIRD	2002	INDEX
19	Western Plains Prime Lamb Group PIRD	2000	INDEX
20	Project MAXEM - PIRD	2000	EMD
21	Elmore - Ewe & Ram Evaluation PIRD	1999	WT

No	Product	End Date	Focus
	ACROSS MEAT, MATERNAL AND MERINO		
22	Information Nucleus Flock	2012+	WOOL + CARCASE
23	Sheep CRC Meat Program	2012+	CARCASE, CONCURRENT SELECTION
24	Genetic Trends in the Australian Sheep Industries	2009	INDEX + MJR TRAITS
25	Sheep Productivity Trials/Ewe Competitions/Linked Trials		WOOL + CARCASE
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27	Elmore - Ewes for the Future	2012+	WOOL + CARCASE
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28	Qplu$ Project	2007	FD, GFW, INDEX
29	Merino Superior Sires	2012+	WOOL +
30	Rylington Merino Flock	2012+	WEC
31	Selection Demonstration Flock	2005	FD, GFW, INDEX +
32	Breeding for Breech Strike Resistance Flocks	2012+	BREECH
33	Merino Bloodline Performance Package	2012+	WOOL +
34	Peter Westblade Memorial Merino Challenge	2012+	WOOL + CARCASE
35	Towards 13 Microns	2007	FD, CFW, SS
36	Nemesis	2003	WEC
37	Better Breeding	2001	WOOL + CARCASE
38	On Farm Progeny Testing	2001	WOOL +
39	Merinos to Match	2005	FD, CFW, CV, WT
40	Turkey Lane – a Commercial Example of Success	2012+	FD, CFW
41	Merino Wether Challenge	2007	WOOL + CARCASE
42	CSIRO Fine Wool Project	2000	FD, CFW, SS, STYLE
43	Hillcott Grove - Bloodline Comparison	2003	FD, CFW, WT
44	The South Roxby Project / Worlds Finest Ram Project	2002	FD, CFW, SS, STYLE
45	Merino Weaner Growth Paths Affects Prime Lamb Production	2007	WOOL + CARCASE
46	SP Toolkit – What are the Benefits of Sheep Genetics		GENERAL

Number	1
Name	**NSW Boning Room Trial**
Traits researched	EMD, WT, FAT
Date	2005
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	MMFS - NSW DPI - Ashley White - PPT
Contact	Ashley White, NSW DPI, Ph: 02 6349 9727 E: ashley.white@industry.nsw.gov.au

Further Information

Permission	Ensure that NSW DPI is acknowledged and Brent McLeod is the driver. Papers from the International Congress of Meat Science and Technology have been provided with full permission from the authors.
Summary of resources	Summary power point slides Three papers provided
File and format	**1** Pop_meat_gemma variation.ppt **1a** McLeod, B.M., White, A.K., O'Halloran, W.J. and Nielsen, S.G. (2007). Predicting the boning room value of lamb carcases from selected indicator cuts. *Proceedings of International Congress of Meat Science and Technology*, 53, pp139-140 Predicting Boning Room Value from Indicator Cuts 53rd ICMST.pdf **1b** McLeod, B.M., White, A.K., O'Halloran, W.J. and Nielsen, S.G. (2007). Selection of flock rams for eye muscle depth will improve lamb boning room profitability of their progeny. *Proceedings of Association for the Advancement of Animal Breeding and Genetics*, 17, pp207-210. AAABG2007.pdf **1c** White, A.K., McLeod, B.M., Richards, J.S., O'Halloran, W.J. and Atkins, K.D. (2007). The effect of eye muscle depth breeding values on lamb dressing percentage. *Proceedings of International Congress of Meat Science and Technology*, 53, pp 141-142. The effect of Eye Muscle Breeding Values on lamb dressing percentage.pdf

Key Findings

- This was a boning room demonstration showing that selection for superior EMD ASBVs will produce progeny with superior EMD.
- A difference of 2.38 % in boning room value and profitability ($3.32) was found between progeny of high and low eye muscle depth (PEMD) rams.
- Commercial industry is not currently rewarded for improved muscle.

Useful Information

- Three syndicate-mated high LAMBPLAN Carcase Plus Index (CPI) sires.
- The progeny of rams selected for high growth rates, leanness and high muscling were compared post slaughter to the progeny of three rams of similar high CPI selected for high growth rates, leanness but low muscling.
- Both groups were joined to randomised first cross ewes.

Background

This was a small trial with 400 lambs but is still the largest scale commercial boning room trial undertaken.

The major difference is in the ASBV for EMD. The PWT and PFAT EBVs are as similar as possible. Carcase weight and fat will have a major influence on yield so must be similar to minimise variation due to weight and fat.

Rams used in 2005 lambing:

Ref 1a

	ASBV PWT	ASBV PFAT	ASBV PEMD
HIGH MUSCLE	9.274	-0.471	1.463
	9.185	-0.675	1.056
	9.500	-0.9	1.0
AVERAGE	**9.32**	**-0.682**	**1.173**
LOW MUSCLE	9.84	-0.84	-1.3
	6.784	-0.555	-1.118
	8.662	-0.921	-0.838
AVERAGE	**8.43**	**-0.772**	**-1.085**

Top 10% and bottom 10% in LAMBPLAN for PEMD

Results

Ref 1b

Table 3 Value of primal cuts, trim, fat and bone ($) based on predicted mean carcase cut weight for high and low muscle ram progeny groups

Primal cut	Value ($/kg)	High muscle	Low muscle
Boneless square cut shoulder	6.50	23.92	24.375
USDA shanks	3.50	2.485	2.415
8pt FTR	28.00	47.60	46.76
Eye of shortloin- silver skin on	28.00	19.32	17.64
Tenderloin	26.00	4.16	3.90
Boneless leg	7.50	41.025	40.20
Trim	1.50	4.185	4.08
Fat	0.04	0.0488	0.0516
Bone	0.02	0.0962	0.0968
Total carcass value		$142.84	$139.52

- Selecting for PEMD will increase loin cut weight and leg weight whilst decreasing lower value forequarter weight.
- 2.38% increase in value may seem small but will have a big impact on the profitability of a processing business.
- For example, from the findings of this study, a boning room processing 3000 lambs per day will increase its returns by approximately $2.5 million dollars per year when processing lambs of equivalent HSCW and GR.

Number	2
Name	**Selection of High and Low Growth Rams - Rod Peart**
Traits researched	Growth, PWT
Date	2003
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	MMFS - NSW DPI - Ashley White – PPT
Contact	Ashley White, NSW DPI, Ph: 02 6349 9727 E: ashley.white@industry.nsw.gov.au

Further Information

Permission	Ensure that NSW DPI is acknowledged and Brent McLeod is the driver.
Summary of resources	Only published internally – PowerPoint presentation is the only available reference
File and format	**1** Powerpoint Slides – Pop_meat_gemma variation.ppt

Key Findings

- This was a commercial demonstration of the production outcomes and resulting value from selecting terminal sires with higher growth rates (based on ASBVs).
- Faster growth and higher carcase weights improved returns.
- Breeding values deliver triple bottom line results.

Useful Information

- Lambs (resulting progeny) were weighed every 2-3 weeks.
- Base carcase price is $3.35/kg.
- Poll Dorset sires were used over first cross ewes.

Background

In a commercial demonstration at Tooraweenah (North of Dubbo, NSW), two groups of Poll Dorset rams were mated to first cross ewes at Rod and Margaret Peart’s property.

In 2003, Rod was disillusioned by the performance of his lambs so he set out to make major changes. He set himself three aims:

- To maximise the number of lambs sold prior to mid-November (6 months of age) without jeopardising carcase weight.
- To improve the quality of his lambs sent to the processor.
- To investigate whether faster growth would improve his returns.

Ewes were randomly split into groups and joined to compare the performance of high PWT - carcase plus index rams **(NEWLY PURCHASED)** against low PWT - carcase plus index rams **(HISTORICAL PURCHASES)**. Detailed ASBVs for each ram team are shown in the table below.

Ref 1

Average ASBVs for sire group (across flock)

Sire Group	Birth weight	Growth (PWT)	P Fat	P EMD	Carcase + index
Yellow	0.12	8.9	-0.66	0.43	169.3
Orange	0.07	1.6	0.10	0.16	112.7

Top 20% and bottom 20% of rams in LAMBPLAN and NOT visually different for size/growth

The Peart's run a mixed farming operation which involves joining 2000 1st X cross ewes in Nov/Dec to lamb in April /May. Lambs have generally been sold from Sept to May at target weight of 20-26kg HSCW. Historically, the average lamb carcase weight has been 23kg with approximately 50% sold prior to Christmas and the remainder shorn and carried through until autumn and sold at 10-12 months of age.

In the trial, the ewes were lambed onto lucerne in April/May and the lambs weaned onto a wheat crop. No differences were observed in ewe fat score at lambing, marking percentages or ewe losses.

Lambs were weighed every 2-3 weeks after weaning and marketed as they reached the weight and fat specifications.

Results

- Lambs from high PWT rams gained 50g/day more than lambs from low PWT rams

	% OF MOB KILLED & HSCW @ 20 WKS	% OF MOB KILLED & HSCW @ 27 WKS
YELLOW	57.2% @ 24.18kg	97.3% @ 24.02 kg
ORANGE	26.1% @ 22.49 kg	77.3% @ 22.76 kg

THE EXTRA CARCASS WEIGHT RETURNED THE PRODUCER AN EXTRA $8.75/HD

Source: McLeod and White NSW DPI

What did this translate to in dollar returns? Assuming 80 lambs/ram/year with 4 joinings:

- $2802.69 more per ram, or
- $700.67 per ram per year

The high growth lambs were 5.44kg heavier at first slaughter date:

- Using a market price of $3.50/kg.
- @ 46% DP lambs would be 2.5kg HSCW heavier.
- $8.75 per lamb extra.
- @80 lambs /ram/year with 4 joinings.
- $2802.69 more $$ per ram of $700.67 per ram per year.

Number	3
Name	**Project Hi-Low - PIRD**
Traits researched	Growth, PWT
Date	1998
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	MLA PIRD
Contact	Keith Ladyman, Ph: 08 9822 7027 E: kantara@skymesh.net.au

Further Information

Permission	Yes
Summary of resources	Final report from MLA and summary
File and format	**3a** Hi-low rams.pdf **3b** *(MLA final PIRD report)* WA Poll Dorset 1998.pdf

Key Findings:

- Poll Dorset high growth rams make more money in WA.
- High growth lambs (LAMBPLAN yearling weight of +4kg with fat and muscle as close to 0 as possible) grew 13.6g/day faster than low growth lambs. This growth rate is in excess of the predicted growth rate of 12g/day.
- This was an older trial which used EBVs to select sires rather than ASBVs.

Useful Information:

- This PIRD trial conducted in Western Australia by the Poll Dorset Association of WA.
- The project aimed to significantly increase the number of commercial prime lamb producers seeking high performance LAMBPLAN sires, as evidenced by both auction and private ram sales.
- Two sites were chosen: Cunderdin (northern) and Pingelly (southern).
- 400 Merino ewes divided and randomly mated to high and low ranked sires on each site.
- Monthly weighing of ewes was carried out.
- Comparison with high growth rams with average growth rams.
- Small first draft of lambs from Cunderdin were sold at $1.45/kg carcase weight for class 18 score 2/3 and $1.55/kg for Class 20 score 2/3. All other lambs were sold at $1.30/kg for Class 18 Score 2/3 and $1.40/kg for Class 20 Score 2/3. Skin prices varied from 0.50c to 0.0c across the drafts.

Background:

The aim of the 'Hi-Low' trial was to address a "widespread lack of awareness and appreciation of LAMBPLAN" which was thought to be adversely affecting productivity gains in prime lamb flocks. Once ram sources were agreed upon, LAMBPLAN recommended indices and EBVs relating to high and low groups: a difference in LAMBPLAN yearling weight EBV of +4 kg, with EBVs for fat and muscle as close to 0 as possible.

About 400 Merino ewes, randomly selected into two groups of 200, were joined to high and low ranked sires on each site. The ewes were not pregnancy-scanned to remove empties or identify twins because of labour costs and time management. Monthly weighing began on schedule, with the northern site starting about one month ahead of the southern site. Seasonal conditions were "particularly tight" during the crucial growth months of June-July.

Lice in the Northern site flock, discovered at lamb marking, affected stock presentation and may also have affected growth. The high performance rams had LAMBPLAN yearling weight EBVs of plus four kilograms. It was predicted these rams would give a 12 grams/day weight gain advantage. They exceeded this.

Results

The bottom line was that more progeny of higher performing sires reach slaughter weights faster, compared with the progeny of lesser rams. In fact, they grew up to 22 grams a day faster than those sired by 'average' rams. This is especially important in alliance marketing programs, or in areas with an early season end.

High growth progeny at the Cunderdin (northern) and Pingelly (southern) trial sites showed an average 6.8g/day and 13.6g/day superior growth rate respectively over the average rams. During the period of maximum growth, the progeny of rams at both sites showed a growth advantage of 22g/day.

The other key finding related to the percentage of lambs in each group reaching slaughter weight. At the Pingelly site, 82% of high group lambs attained slaughter weight in a six week period of monitored turn off, while 76% of low group progeny reached slaughter weight in this time.

Ref 3b

Number of lambs slaughtered

Slaughter date	Cunderdin High	Cunderdin Low	Cunderdin Diff.	Pingelly High	Pingelly Low	Pingelly Diff.
6 Sept	22	7	+15			
4 Oct	68	56	+12			
12 Oct				48	38	+10
25 Oct				31	24	+7
10 Nov				27	37	-10
25 Nov				22	17	+5
Total slaughtered*	**93**	**65**	**+28**	**131**	**119**	**+12**
Store lambs	51	85	-34	19	29	-10
Dead, missing, lost tag	23	24	-1	9	8	+1
Lambs marked	167	174	-7	159	156	+3

* includes five lambs at each site which were slaughtered for demonstration purposes at the field days.

A four week monitored turn off period was used at Cunderdin. The difference here was more marked. A total of 56% of the high group lambs reached slaughter weight during that time compared with 37% of low group progeny. Lambing percentage at both sites was similar-about 88% at Cunderdin and 82% at Pingelly.

Overall income advantage from the lambs in the high group over the low groups was $101 a ram at the Cunderdin site and $203 at Pingelly. This difference does not account for the savings in costs such as feed, shearing or animal health treatments which are saved by turning off lambs sooner.

Ref 3b

Slaughter data and income

	Cunderdin			Pingelly		
	High	Low	Diff.	High	Low	Diff.
Final liveweight (kg)	39.6	39.8	-0.2	40.3	40.0	+0.3
Carcase weight (kg)	17.6	18.1	-0.5*	18.6	18.3	+0.3
Fat score (1 to 5)	2.2	2.6	-0.4*	2.6	2.5	+0.1
Dressing percentage	44.4	45.5	-1.1*	46.2	45.8	+0.4
Price rate ($/kg)	1.31	1.32	-0.01	1.33	1.32	+0.01
Value ($/head)	23.64	24.43	-0.79	25.03	24.59	+0.44
Income suckers ($)	2198	1588	+610	3279	2926	+353
Income stores ($)	765	1275	-510	285	435	-150
Total income ($)	**2963**	**2862**	**+101**	**3564**	**3361**	**+203**

* indicates a significant difference between the high and low groups ($P < 0.05$).

Most of the profit difference was due to the increased number of lambs from the high group achieving the slaughter price rather than a store value because of their higher growth rates.

A ram with a 3.7kg advantage in EBVs for yearling weight is worth an additional $68/year for each year of its working life – just under $20 more income per year for every 1 kg extra LAMBPLAN EBV for yearling weight.

Number	4
Name	**Accelerator Breeding Producer Group PIRD** *Benchmarking the link between value export cuts and genetic traits*
Traits researched	HSCW, PWT, PEMD, PFAT, subjective FAT, Carcase length, fat depth, length of carcase, width of loin and rib to rump length Also measured as an average across each sire, weight of shoulder, shin, neck, leg, trim, loin, rack, caps, flaps caps, flaps and length of loin
Date	2003
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	MLA PIRD
Contact	Ian Pfeiffer, Ph: 08 8752 0781 E: fifer@lm.net.au Casey Work (daughter of Ian Pfeiffer) E: casey.work@sa.gov.au
What's missing	Could create charts of correlation between carcase value and PFAT, PEMD and PWT.

Further Information

Permission	Yes
Summary of resources	Final PIRD Report
File and format	**4a** Accelerator PIRD final report 19Jun08.pdf

Key Findings

- Sire ASBVs predicted progeny performance accurately therefore commercial producers can have confidence that sires will breed true to their ASBVs.
- "Carcase Plus" index predicted total carcase value to Tatiara Meat Company more accurately than sire post-weaning weight ASBV.

Useful Information

- 230 first cross Border Leicester/ Merino ewes were mated by AI to White Suffolk sires and one Poll Dorset sire selected for superior ASBVs or widely used in the industry up to 2003.
- Ewes were run in one management group as much as possible.
- All ewes were monitored daily and birth date and birth type was recorded.
- Approximately two weeks after the start of lambing (after all ewes had lambed) lambs were weighed (referred to as birth-weight), and their sex and rear type were recorded.

- Lambs were managed in one group until slaughter.
- Lambs were also weighed at 50, 100 and 150 days and scanned to assess fat depth and eye muscle depth at 150 days.
- The progeny were slaughtered at 160 days of age having achieved export weights.
- Tatiara Meat Company MC allocated carcase value ($/kg) for each cut of meat. The cuts were weighed per sire and averaged based on the number of progeny from that sire. This information was then used to calculate average carcase value for each sire.

Background

Genetic progress is currently focused on Australian Sheep Breeding Values (ASBVs) for birth weight, weaning weight, post-weaning weight, post-weaning fat depth and post-weaning eye muscle depth. A range of indices has also been developed based on these ASBVs, the most widely-used being Carcase Plus, which incorporates post-weaning ASBVs for weight, fat depth and eye muscle depth.

The value of using these ASBVs and/or indices is not currently passed on to commercial and seed-stock producers, as their role in producing superior prime lambs is not recognised by the processors. If the value could be estimated, this could provide breeding direction to both commercial producers and ram producers.

Approximately 230 first cross Border Leicester/Merino ewes were inseminated with semen from a range of White Suffolk sires and one Poll Dorset sire which were selected as a result of demonstrating superior ASBVs or having been widely used in the industry up to 2003.

Table 1 Sire ASBVs as at the October 2007 run (LAMBPLAN, 2007).

Sire	Birthweight ASBV	Weaning weight ASBV	Post-weaning weight ASBV	Post-weaning eye muscle depth ASBV	Post-weaning fat depth ASBV	Carcase +
211	0.18	8.10	11.97	2.28	-0.62	186.66
904	0.69	5.79	8.90	-0.55	-1.22	157.06
1985	0.16	6.92	12.61	-0.36	-0.69	170.20
196	-0.38	5.18	8.10	1.56	0.37	148.23
201	-0.01	3.94	6.60	1.41	0.06	143.60
360	0.14	6.77	10.60	-0.26	-0.91	163.77
10	-0.14	4.06	5.74	2.51	0.78	138.28
41	-0.10	5.18	7.50	0.09	-0.54	145.81
305	0.14	4.55	7.43	-0.03	-0.62	145.59
20	-0.03	4.60	6.51	0.68	-0.47	144.52
61	0.42	6.75	9.93	-0.54	-1.08	160.38
309	-0.07	2.87	3.97	1.77	0.25	130.63
362	0.24	4.99	7.09	-0.19	-0.71	143.79

Rams were selected on their ASBVs prior to insemination in 2003. As resources were unavailable earlier, the analysis of the trial data commenced in 2007 and the 2007 ASBVs of the rams have been used in the data analysis.

The progeny were slaughtered at 160 days of age, having achieved export weights, and the following traits were measured for each lamb: hot standard carcase weight, subjective fat score, fat depth, length of carcase, width of loin and rib to rump length. Also measured as an average across each sire were the weights of shoulder, shin, neck, leg, trim, loin, rack, caps, flaps caps, flaps and length of loin.

Results

Carcase specifications and value

Lambs averaged a carcase weight of 27kg at 160 days of age and ranged between 25 and 28.4kg. Based on the average carcase weight, lambs grew at approximately 300 grams per head per day.

Progeny fat scores ranged from 2 to 5 and averaged 3.9. Fat scores were calculated from measured fat depth. 25% of lambs in the trial had a fat score of 5. There was no correlation found between hot standard carcase weight and fat score (r = 0.256, P<0.001) (Figure 2) or post-weaning weight ASBV and fat score (r=-0.099, P=0.096).

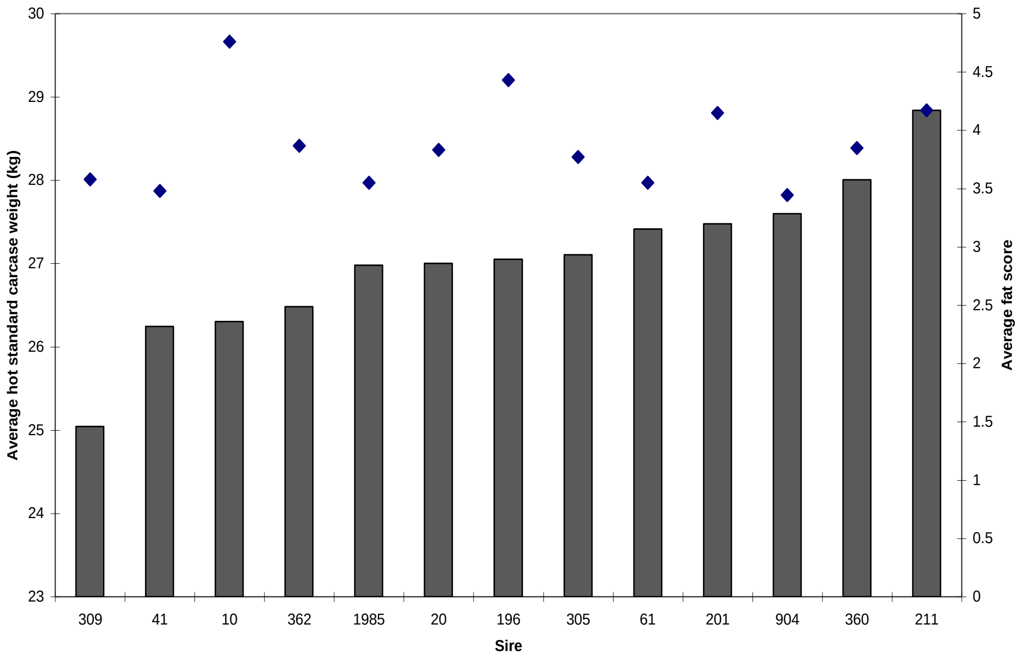


Figure 2 Average hot standard carcase weight (kg, grey column) for each sire and associated average fat score (♦).

The average progeny carcase value from each sire to the processor ranged between $120.53 and $135.95 while the average value of primal cuts ranged between $93.99 and $105.18. Hot standard carcase weight accounted for 84.3% of variation in total carcase value (P<0.001).

Sire ASBVs and progeny performance

Progeny performance was significantly affected by sex, gestation length, birth type and rear type. Once these factors were accounted for, progeny performance was as expected, based on sire ASBV:

- An increase in sire post weaning weight ASBV of 1kg increased progeny 150 day weight by 0.48kg (± 0.20kg)
- An increase in sire post weaning eye muscle depth ASBV of 1mm increased progeny 150 day eye muscle depth by 0.58mm (± 0.14mm)
- An increase in sire post weaning fat depth of 1mm increased progeny 150 day fat depth by 0.43mm (± 0.19mm) (Figure 3).

Sire post weaning ASBVs predicted their respective progeny traits more accurately than sire weaning weight and birth weight ASBVs.

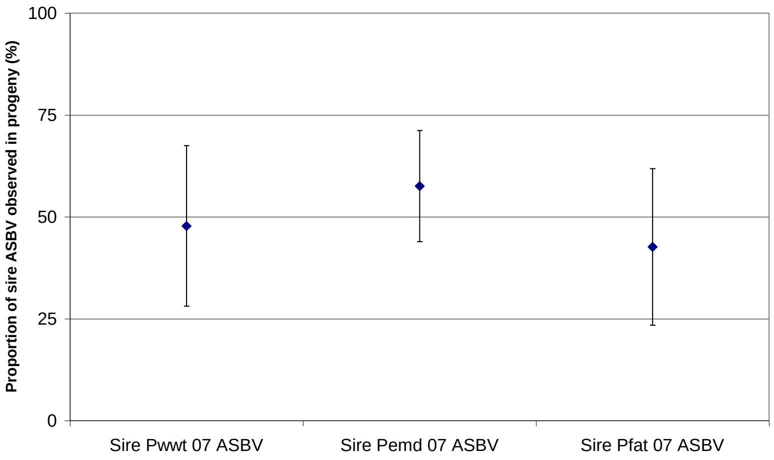


Figure 3 Proportion of sire post weaning weight (PWT), post weaning eye muscle depth (PEMD) and post weaning fat depth (PFAT) ASBVs observed in progeny. Expected proportion is 50%.

Traits that will convert into better farm-gate returns

Producers are paid based on carcase weight. When adjusted for sex, gestation length and birth type, the sire post weaning weight ASBV was positively associated with progeny hot standard carcase weight (r=0.44, P<0.001). The sire Carcase Plus index is also positively related to progeny hot standard carcase weight (r=0.45, P<0.001).

Sire Carcase Plus index predicted progeny total carcase value to TMC more accurately than the sire post weaning weight ASBV. For the range of Carcase Plus indices tested, every point increase in sire Carcase Plus index equated to 20.6 cents extra carcase value to the processor (Figure 4). The Carcase Plus index is a combination of sire post-weaning weight, eye muscle and fat depth ASBVs. Of these, sire post weaning weight ASBV had the most influence on carcase value (r^2=0.4597) followed by PFAT (r^2=0.3612) and PEMD (r^2=0.0361)

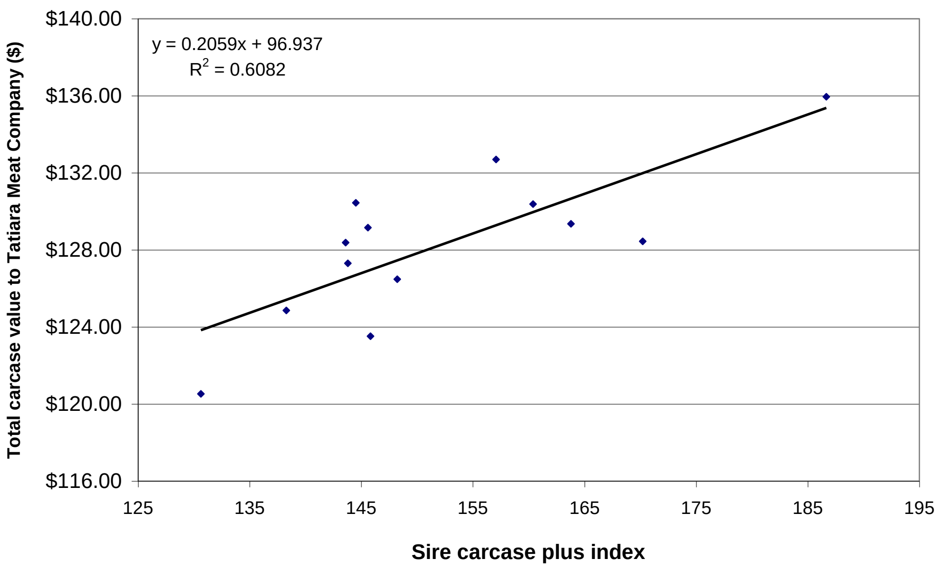


Figure 4 Relationship between sire Carcase Plus index and total carcase value ($) to the processor.

Number	5
Name	**White Suffolk PIRD Trial**
Traits researched	BWT, EMD, FAT, lambing observations, WT, WEC, OFDA for medullated fibre, length measurements. Slaughter carcase traits: carcase WT, GR fat depth, short loin length, weight of loin, rack, tenderloin, leg, forequarter, shank, bone, trim, fat weight, forequarter fat weight.
Date	2004
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	MLA PIRD
Contact	Troy Fischer M: 0409 589 559 E: troyfischer@bigpond.com
What's missing	*Need chart that shows growth EBV versus growth results*

Further Information

Permission	Yes
Summary of resources	Final report Power point presentation from Troy Fischer
File and format	**5a** WS PIRD Report – Final.pdf **5b** WS PIRD - Launceston Feb 2005.ppt

Key Findings

- Sires with higher BWT EBVs produced more lambing difficulties and longer gestation.
- Different sires had different growth patterns with some having progeny heavier at certain ages and lighter at others.
- Carcase EBVS are a good indicator of carcase traits at various ages.
- Carcase EBVS and LAMBPLAN indices are an accurate indicator of carcase value and are useful tools for breeding animals with more weight in the high value cuts, and therefore higher value lambs.
- There was little or no relationship between length and carcase weight or loin weight.

Useful Information

- MLA funded PIRD trial.
- Project aim was to highlight differences in progeny performance between high and low EBV sires:
    - Growth traits.

    - Carcase traits – live and slaughter.
- Focus on usefulness of carcase EBVs to determine carcase value.
- Run on Andrew Heinrich's property on Kangaroo Island, SA.
- 300 Merino ewes inseminated to 15 sires (20 ewes each) – 13 White Suffolk, 2 Poll Dorset.
- Progeny relocated to Peter Heinrich's property at Bute, SA.
- Multiple growth and carcase measurements, plus slaughter measurements.
- Carcase value not corrected for carcase wt - heaviest carcase = heaviest primal weights = highest value (Growth (kg) is the profit driver)

  Primal weights – retail values provided by Struan Meats
    - French rack - $26/kg
    - Eye of loin - $35/kg
    - Tenderloin - $30/kg
    - Boneless leg - $10.9/kg
    - Boneless forequarter - $9.9/kg
    - Fat and bone (rendering), trim weight ($2.5/kg), shanks ($2.5 each)

Background

Approximately 300 Merino ewes were inseminated to 15 different high profile industry sires (20 ewes per sire), as detailed in *ref 5a*. There were 13 White Suffolk sires and 2 Poll Dorset sires used in the trial. It is important to note that there were some adverse weather conditions at the time of lambing. This combined with many multiple births resulted in significant mortality rate of lambs. This was not specific to individual sires but some sires lost more lambs than others.

Multiple body weights, live carcase assessments and lambing observations were recorded. OFDA measurements were taken on fleece samples at shearing to measure the level of medullated fibre for each of the sire's progeny. Worm egg count was recorded for progeny. The animals were slaughtered at an average of 287 days old at Struan Meats and a series of carcase traits was measured.

The structure of the trial had a number of limitations which need to be considered when interpreting the results. Only male lambs were slaughtered, an average of 6.2 progeny per sire. No maternal effects were accounted for in the analysis.

All measures were corrected for major effects; for example sex, rear type and carcase weight. The level of error with respect to the results increases as progeny groups decreases in size.

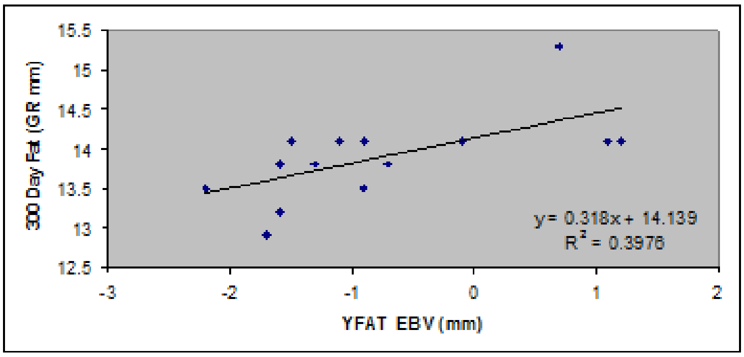
Results

NB: Please ensure that you have read over the limitations of the results as stated above in the "background" section.

The growth rate results demonstrated a need for multiple liveweight measures as there were marked differences in growth patterns between individual sires. The correlation between carcase measures at post weaning age (200 days) and yearling age (365 days) is not 1. As a result, it is suggested that for breeders wishing to provide accurate information to their clients at both ages (for example, domestic or export market purposes), measuring these traits at multiple times will be beneficial.

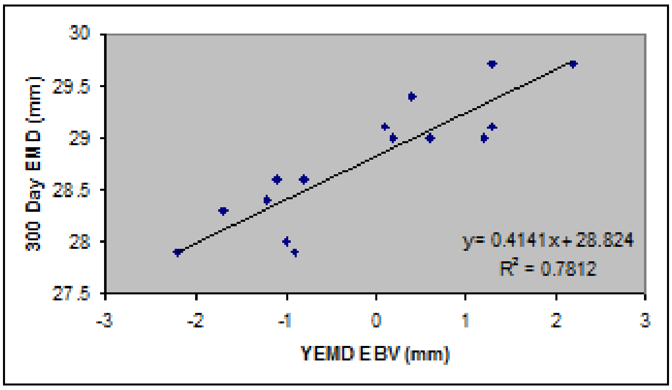
Sires generally performed according to their EBVs.

Live Carcase Traits – Fat Depth



- Negative fat EBVs = leaner lambs
- Similar trend at 150, 200 and 300 days

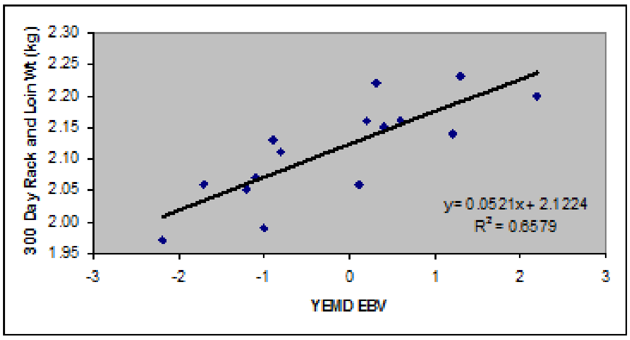
Live Carcase Traits – EMD



- Positive EMD EBVs = more muscular lambs
- Similar trend at 150, 200 and 300 days

Growth and Carcase EBVs and the LAMBPLAN indices are useful tools for increasing the value of prime lambs produced. Strong relationship between EMD EBV and rack and loin weight – heavier high value cuts.

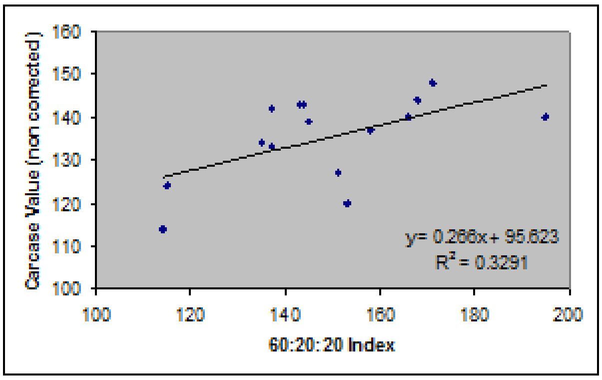
Slaughter Traits – Rack and Loin Weight



- Strong +ve r/ship b/w EMD EBV & highest value cuts in the carcase

A difference of $34 per lamb was seen between the highest and lowest value progeny groups which equates to $5,440 additional value over the life of the sire.

Carcase Value vs. 60:20:20 Index



- Positive r/ship between carcase value and 60:20:20

Number	6
Name	**Uralba Stud Cleve – On Farm Index Comparison Trial**
Traits researched	YWT, HSCW, FAT
Date	1998
Target audience	Ram breeders and ram buyers
Target	Meat
Source	PIRSA
Contact	Brian Ashton, M: 0438 088 220 E: ashtonba@gmail.com Paul Dolling, Ph: 08 8620 7045

Further Information

Permission	Yes
Summary of resources	Article in SA Lamb
File and format	**6a** Uralba index comparison.pdf **6b** Uralba index comparison part 2.pdf

Key Findings

- Dolling family of Cleve demonstrated to their clients that EBVs make more money.
- LAMBPLAN works to make more money for ram buyers.

Useful Information

- Three groups of 43 adult Merino ewes were joined to three rams: three low grade rams (LAMBPLAN Carcase Plus index of 85), three high grade rams (Carcase Plus average index of 114) and three stud rams joined to stud ewes (half American Suffolk rams).
- The ewes were managed together after joining.
- The lambs were sold at 8 months of age with a carcase value of $1.80 per kg for those below 20kg and $2.00 per kg for above export weight, no penalty for fat score.

Background

White Suffolk breeders, the Dolling family of Uralba stud at Cleve on Eyre Peninsula, wanted to show that their selection methods make more money for their clients. Clients of LAMBPLAN, they joined low, high and stud rams to even lines of Merino ewes – they also involved in the comparison a group of stud rams joined to stud ewes. The performance of the stud group is for interest only and the ewe base is not comparable to the trial.

Results

Ref 6a

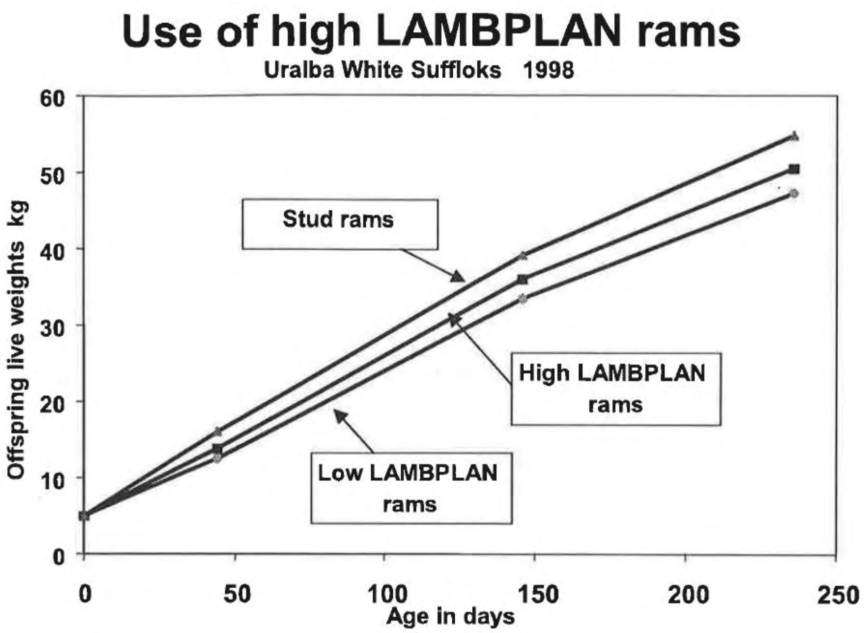
The differences in liveweight between the low and high grade rams were observed from lamb marking. The following table captures performance from lamb marking onwards.

	Low	High	Stud
8 months liveweight	47.3kg	50.5kg	54.8kg
Over the hooks carcase wt	21.9kg	23.5kg	24.4kg
% below 20kg	19%	8%	4%
Return per carcase $	$43.12	$46.71	$48.71

Such differences mean more profit for the commercial lamb producer. The difference between the lambs from the low and high commercial flock rams ($3.59) could mean an additional $1,795 more income for a producer selling 500 lambs. If a ram sires 200 lambs in his lifetime, and each lambs returns $3.59 more income, he earns $718 more. Consequently, it is worth paying more for him.

The superior performance of the stud rams demonstrates that the stud will deliver superior genetics for clients into the future.

Ref 6b



Number	7
Name	**Maternal Central Progeny Test**
Traits researched	PWWT, PWT,PFAT, PEMD, Reproduction, Slaughter measurements: hot carcase weight, depth and width measurements of C fat, muscle pH and colour, GFW, FD, YLD, milk production, WEC
Date	1997 – 2005
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	NSW DPI, Victoria DPI, PIRSA and MLA
Contact	Dr Neal Fogarty, NSW DPI. E: neal.fogarty@dpi.nsw.gov.au Ashley White, NSW DPI Ph: 02 6349 9727 E: ashley.white@nsw.gov.au

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	18 scientific papers 17 conference papers 18 technical conference contributions 156 advisory communications largely through industry newsletters and journals, Dynamic Dams Newsletter
File and format	**7a** TechBull50.pdf **7b** mcpt MLA final project report.pdf **7c Ingham Paper AAABG** Ingham, VM; Fogarty, NM; Gilmour, AR; Brown, DJ; Cummins, LJ; Gaunt, GM; Stafford, J; Hocking Edwards, JE (2005). Relationships between LAMBPLAN EBVS for rams and post weaning performance of their crossbred progeny. *Proc. Assoc. Advmt. Anim. Breed. Genet.* ***16****: 227-230.* AAABG05_227ingham.pdf **7d Power point presentation AAABG** Fogarty, NM, Ingham, VM, Cummins, LJ and Gaunt, GM (2005). Variation among maternal sires for lamb and wool gross margin performance of their crossbred daughters. *Proceedings of the*

	Association for the Advancement of Animal Breeding and Genetics **16.** AAABG05mcptFogarty149_2.ppt **7e List of project references** (not cited) mcptpubs may 2012.pdf

Key Findings

- A range in profitability of over $40 gross margin/ewe/year is attributable to the maternal sire of crossbred ewes.
- Lamb turnoff rate is the main profit driver but 2ndX lamb growth and carcase fat (which affect the proportion of lambs meeting market specifications) and ewe wool also contribute.
- There are important differences between maternal sire breeds for reproduction, growth, milk, carcase fat, fleece weight and fibre diameter.
- There is considerably more variation among sire groups within breeds than between breeds with overlap of breeds for most traits.
- The use of LAMBPLAN EBVs to assist in selection is the best way to exploit the genetic variation and improve maternal performance.

Useful Information

- Maternal Sire Central Progeny Test (MCPT) progeny-tested 91 sires from several maternal breeds including Border Leicester, Coopworth, East Friesian and Finnsheep.
- 4 sites were involved at: Cowra, NSW, Hamilton and Rutherglen Vic and Struan, SA.
- Common sires were used to provide genetic links across the sites and years for combined analysis.
- The focus was on evaluation of the 1stX ewe progeny which were grown out and mated for 3 lambings.
- Performance of the 2,700 1stX ewes was assessed by their lamb turnoff rate, the growth and carcase merit of their 11,000 2ndX lambs, and their wool production.
- Gross margin calculation (see ref 7b) – base carcase price is $3.35/kg for carcase in specification (>20kg and fat score 2-4)
- Wool price based on 10 year averages 1995-2004.

Background

Productivity of the crossbred ewe flock has a major impact on the profitability of lamb enterprises. The challenge is to achieve greater genetic improvement among commercial flocks of crossbred ewes. To address this challenge, breeders and lamb producers together with the State Departments in NSW, Victoria and SA and Meat and Livestock Australia initiated a national maternal sire central progeny test (MCPT) in 1997.

The objective of the MCPT was to measure the variation in first and second cross progeny performance of maternal and dual purpose (meat and wool) sires and evaluate the scope for genetic improvement in the sector.

The MCPT progeny tested 91 sires from several maternal breeds including Border Leicester, Coopworth, East Friesian and Finnsheep at 4 sites in south eastern Australia (Cowra, NSW, Hamilton and Rutherglen Vic and Struan, SA). The major focus was on evaluation of the 2,700 1stX ewe progeny and their 11,000 2ndX slaughter lambs. Survival, growth and carcase performance of 1stX lambs were also measured.

Results

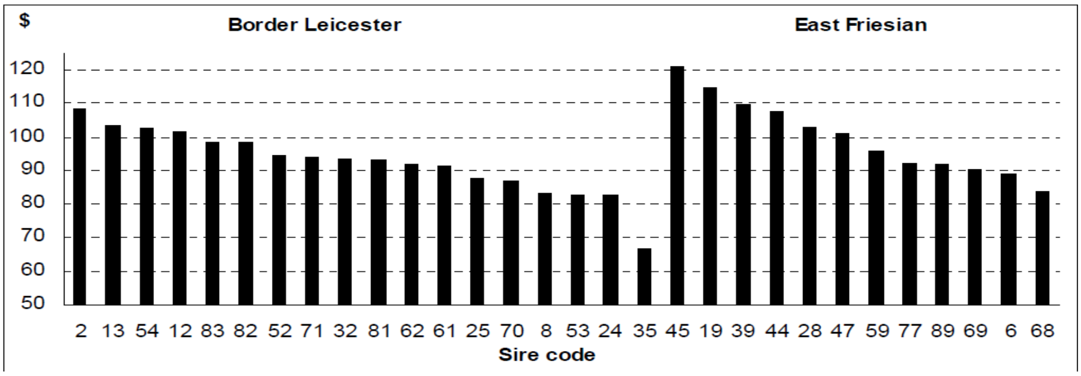
Ref11a

The results clearly demonstrated the considerable genetic variation within maternal genetics, variation that can be exploited to dramatically improve the productivity and profitability of lamb enterprises.

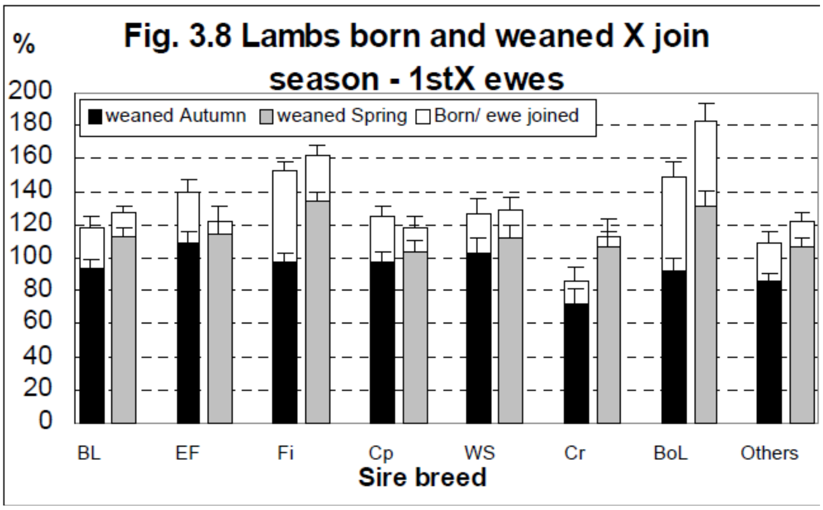
There was a range in profitability of over $40 gross margin/ewe/year among the 1stX daughters of the sires tested. This can mean more than $20,000 higher annual profit for the average lamb producer. On an industry basis, a modest increase of 5% in lamb carcase turnoff amongst the top 30% of production represents an annual increase of over $18 million to producers. (**ref 7a** clearly outlines the gross margin calculation process).

While there were some significant differences between the maternal sire breeds in the performance of their progeny, the variation between individual sires within the breeds was far greater for most production traits. The range among the 18 Border Leicester sires tested was over $40 gross margin/ewe/year in the profitability of their 1stX daughters. This means a $20,000 higher annual profit for a 1000 ewe enterprise by having 1stX ewes sired by top rather than average maternal genetics.

Fig. 2.2 Annual $gross margin - 1stX ewes



Variation in lambing rate of the 1stX ewes was the major profit driver that contributed to the differences in gross margins as over 80% of enterprise income was derived from lamb sales and less than 20% from wool. There were differences of up to 45% for lamb weaning rate between 1stX ewe progeny groups of sires within a breed. In addition, there were significant differences in 2ndX lamb growth (up to 3.6 kg for post weaning weight) and carcase fat (2.2 mm GR or almost half a fat score). These differences contributed to the gross margin through total weight of carcase turned off and varying proportions of the carcases meeting market specifications.



There were also large differences between breeds and sires within breeds for early age of puberty, milk production and weight and fibre diameter of wool from the 1stX ewes. Most breeds had at least some sires that had high performing 1stX daughters.

Taking into account the variation in feed requirements of the 1stX ewes and their 2ndX lambs (which affects carrying capacity) generally had little impact on the rankings of the maternal sires, with a couple of exceptions. The best sire groups of 1stX ewes varied to some extent at least with the production system. For example, some groups of ewes with very high lambing rates performed relatively better in a spring rather than autumn joining system because of better lamb survival at a lambing time when weather conditions were more benign. The importance of carcase weight and fat levels also varied according to whether the target market was domestic or export and whether disposal was under saleyard or grid based selling. This emphasises the importance of breeders clearly identifying their production and marketing system and matching it with the most appropriate genetics.

The correlations between the maternal sire LAMBPLAN EBVs and the growth, carcase and wool production performance of their progeny in MCPT were positive and moderately high. The relative performance of the sires in the growth and carcase of their 1stX progeny was also consistently expressed in their 2ndX progeny. The relationships between LAMBPLAN EBVs of the maternal sires and 1stX ewe reproduction traits were positive although lower than for growth and carcase traits. This reflects the smaller number of animals with recorded reproduction information in the LAMBPLAN database compared to growth and carcase traits, resulting in lower accuracy of these EBVs. The more widespread recording of reproduction information on maternal breed animals should improve the accuracy of these reproduction EBVs.

Table 14.1 Correlations (standard error) between LAMBPLAN Maternal EBVs for maternal sires and MCPT performance of their 1stX and 2ndX progeny

LAMBPLAN	MCPT	Correlation
Post weaning weight	1stX post weaning weight	0.56 ± 0.10
	2ndX post weaning weight	0.27 ± 0.13
Post weaning fat	1stX carcase GR	0.65 ± 0.08
	2ndX carcase GR	0.35 ± 0.12
Post weaning emd	1stX carcase emd	0.56 ± 0.10
	2ndX carcase emd	0.32 ± 0.13
Yearling gfw	1stX yearling gfw	0.43 ± 0.12
Lambs weaned	1stX lambs born	0.27 ± 0.13
	1stX lambs weaned	0.22 ± 0.14

Ref 7c

Table 2. Correlations (± s.e.) between ram LAMBPLAN EBVs (Border Leicester, Maternal, Terminal analyses) and their first and second cross progeny performance in MCPT for post weaning weight (Pwwt), fat depth (Pfat) and eye muscle depth (Pemd)

		Border Leicester	Maternal	Terminal
First cross	Pwwt	0.42 ± 0.11	0.50 ± 0.09	0.48 ± 0.10
	Pfat	0.50 ± 0.10	0.65 ± 0.07	0.53 ± 0.10
	Pemd	0.25 ± 0.13	0.50 ± 0.10	0.50 ± 0.10
Second cross	Pwwt	0.15 ± 0.13	0.22 ± 0.12	0.20 ± 0.12
	Pfat	0.47 ± 0.11	0.33 ± 0.11	0.15 ± 0.13
	Pemd	0.27 ± 0.13	0.28 ± 0.11	0.29 ± 0.12

Ref 7a

Lamb producers can benefit immediately from applying the results of the MCPT project by ensuring that their ewe flocks comprise superior maternal genetics. This means breeding or purchasing crossbred ewes that are by rams with high LAMBPLAN EBVs for the traits that match the lamb enterprise and ensuring that they are bred from high performing base ewe flocks. The results show that an increase of $20 gross margin/ewe/year can be achieved from 1stX ewes by top maternal sires compared to those by average sires.

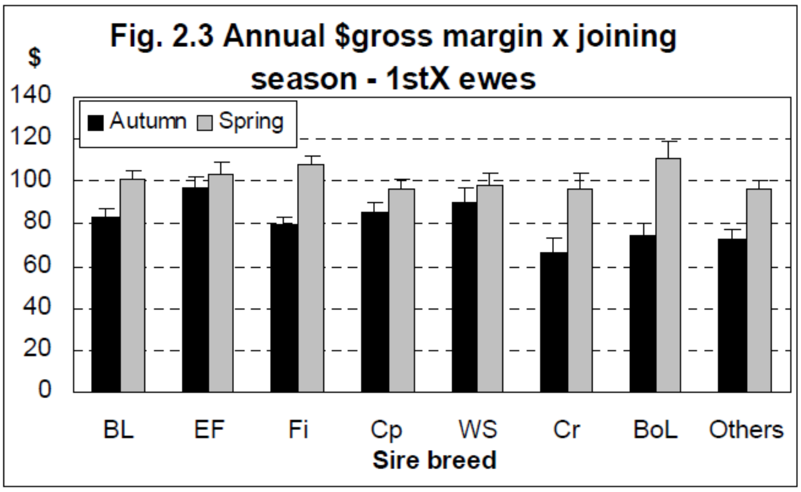


Fig. 2.3 Annual $gross margin x joining season - 1stX ewes
$
140
120
100
80
60
40
20
0
Autumn
Spring
BL
EF
Fi
Cp
WS
Cr
BoL
Others
Sire breed

Number	8
Name	**Value of LAMBPLAN's Muscle EBVs – PIRD**
Traits researched	Growth, WT, FAT, EMD
Date	2001
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	MLA PIRD, Western Australian Texel Stud Breeders Association
Contact	Maria Wood, Te Rakau, BINDI BINDI WA 6574 Ph: 08 9654 3012

Further Information

Permission	Yes
Summary of resources	MLA report
File and format	**8a** Final Report - Value LAMBPLAN Texel PIRD.pdf

Key Findings

- Sucker lambs from rams with high EBVs for growth had faster growth rates, heavier carcase weights but smaller eye muscles than sucker lambs from rams with high EBVs for muscle.
- Carry over lambs from rams with high EBVs for growth had heavier carcase weights but lighter loin and rack cuts and lower retail meat yields compared to carryover lambs from rams with high EBVs for muscle.
- Lambs sired by high muscle rams had higher dressing percentages, deeper eye muscles and lighter coloured meat.

Useful Information

- The trial involved 45 lambs in eight groups, with individual sires for each progeny group tracked. The lambs were weighed when matched to their mothers, weighed as suckers and again as carryover lambs.
- With the weights recorded against their sires through LAMBPLAN, the trial could link the carcase value of each group to the EBV of the individual ram used.
- Lambs were carried through summer at a constant weight and went into feedlot on 4 February 2001. On 22 March 2001, 189 lambs were slaughtered and measured the following day for GR tissue depth and hot carcase weight (HSCW).
- There were two groups of 300 ewes – one Merino and the other crossbred ewes (first cross).

Background

- The trial was established to show that rams can have high index values but the individual performance of the traits in the index may vary to create the index value.
- As a very high EBV for one trait will compensate for a lower EBV in another trait, rams can have an equally high index, but have very different muscling and growth EBVs
- The trial was set up to compare progeny of high index rams with either high EBVs for growth or high EBVs for muscle. The individual rams' EBVs and index values relate to their performance at post weaning age, which is aimed at weight range 45-70kg liveweight or 20-24kg carcase weight.

Table 1 Average EBVs and index values for the high muscle and high growth rams

Rams	PWT	PFAT	PEMD	Index Value Carcase +
High Muscle	0.38	-0.11	2.60	130.62
High Growth	4.47	-0.60	-0.38	133.13
Diff between groups	4.08	-0.49	-2.98	2.51

Results

The main findings from sucker-slaughtering were that lambs sired by high growth rams have heavier liveweights and carcase weights while lambs sired by high muscle rams had higher dressing percentages, deeper eye muscles and lighter coloured meat. There were no differences between groups in fat cover measured as GR tissue depth.

Group	Sire	Carcase Wt (kg)	GR Tissue (mm)	EMD mm
1st Cross	Growth	19.9	8.01	27.78
	Muscle	18.8	8.23	29.71
2nd Cross	Growth	20.9	6.85	30.23
	Muscle	19.5	7.66	30.45

Table 3. Retail meat yield, weight and dollar value for individual and total leg cuts

Group	1st cross growth	1st cross muscle	2nd cross growth	2nd cross muscle
Topside (g)	555	531	578	574
Silverside (g)	406	424	411	462
Rump (g)	246	241	250	270
Round (g)	434	432	458	456
French shank (g)	400	387	404	395
Leg Meat Yield (%)	55.5	55.5	56.5	58.5
Leg Meat Value ($)	$17.39	$17.21	$17.94	$18.52

Table 3. Retail meat yield, weight and dollar value for individual and total leg cuts

Group	1st cross growth	1st cross muscle	2nd cross growth	2nd cross muscle
Topside (g)	555	531	578	574
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Rump (g)	246	241	250	270
Round (g)	434	432	458	456
French shank (g)	400	387	404	395
Leg Meat Yield (%)	55.5	55.5	56.5	58.5
Leg Meat Value ($)	$17.39	$17.21	$17.94	$18.52

Results show high growth rams delivered a gain of 1.25kg carcase weight, which was very close to the predicted gain of 0.97kg (based on sire EBVs) that would have returned the producer an extra $3.31 on WA prices at that time. The trial included bone-out of the lambs which showed a $3.24 advantage (each leg, $1.04 backstrap) in favour of the high muscle groups as a result of better leg and backstrap dollar values. Results from this trial indicate there is a clear difference in the economic weights that would be applied to growth and muscle from a producer or a processor.

Using well-muscled rams to produce progeny with higher meat yields will become increasingly important. However, under current marketing systems which are based on carcase weight, a high growth index is more profitable for the producer while the high muscle index is more profitable for the processor as the current weight and fat payment system does not identify and reward producers for high yielding carcases.

Number	9
Name	**First X Lamb Production in Fine Wool Merino Flocks**
Traits researched	Growth, WT
Date	2005
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	MLA PIRD and Bathurst Merino Association
Contact	Jeff Eppleston Ph: 02 6331 1377 M: 0429 652 888 E: jeff.eppleston@lhpa.org.au Rob McLeod, BMA, Ph: 0427 311 973

Further Information

Permission	Yes
Summary of resources	Final report, interim report, economic analysis
File and format	**9a** Interim Report No 1.pdf **9b** 2004N01_BMA final report.pdf **9c** 2004N01 BMA Economic Analysis.pdf **9d** BMAPIRD Final report Feb07.pdf

Key Findings

- Selecting terminal sires using genetic information targeted to the final lamb market will ensure progeny grow faster, finish earlier and produce higher returns both per head and per hectare than the progeny of visually selected terminal sires.
- Feed supply and stocking rate need to be considered when producing animals of greater liveweights.

Useful Information

- The project had many aims but one element compared the returns per head of known ASBV terminal sires with unknown ASBV terminal sires. Two of the four sites undertook this comparison: Tarana and Dunkeld.
- Two terminal sires were purchased and used at 2 locations as “selected” sires compared to “unselected” sires.

- Finishing systems and production mixes were also compared.
- Holmes & Sacket conducted an economic analysis (***ref 9c***).
- Drought hindered lamb performance so growth rates were lower than expected.

Background

The aim of this work was to improve the profitability of lamb production from members' flocks by comparing the profitability of different lamb production systems from fine-wool Merino sheep and lifting members' skills in the technology of prime lamb production. Some of the activities were about comparing production systems but an element of the work was to compare terminal sires selected on ASBVs with those not selected on ASBVs.

Ref 9a Sires with breeding values used in the terminal sire comparison

Trait	Target EBV	Ram 445/03	Ram 536/03
Growth	**>8 (top 20% of breed)**	**9.0**	**8.5**
Fat	**>-0.5**	**0.4**	**-0.1**
EMD	**>0. 5(top 35% of breed)**	**0.9**	**0.3**
Birth Wt	**Avoid excessive EBV**	**0.07**	**0.15**

- Methodology for the Tarana site:
    - 200 ewes randomly allocated to "selected" or "unselected" terminal sires.
    - Ewes run together as much as possible, multiple liveweights, finished first on oat crop and later on pasture.
    - Lambs 39kg or above at last weighing killed at Cowra.
- Methodology for the Dunkeld site:
    - 250 ewes randomly allocated to "selected" or "unselected" terminal sires.
    - Two different finishing systems, pasture with supplementary feeding, or irrigated pasture.
    - Irrigated lambs grown out to heavier weights and slaughtered at Tamworth at 330 days and pasture lambs killed at Cowra at 274 days.

Results

Tarana

Lambs 39 kg or above at the last weighing were killed at Cowra abattoirs and feedback sheets obtained. Those not reaching kill weight were valued by a local agent and were not monitored further.

Growth rate - Lambs sired by LAMBPLAN 'selected' sires compared to lambs sired by unselected sires were:

- Heavier at weaning (21.4 ± 0.3 vs 20.0 ± 0.5 kg; P<0.05),
- Grew faster to slaughter (123 ± 2 vs. 116± 2.2 g/day; P<0.05)
- Were heavier at slaughter (39.4 ± 0.4 vs. 37.4 ± 0.5 kg; P<0.01), and
- A higher proportion met slaughter specifications (54 of 61 - 87% vs. 41 of 61 – 67%; X2 = *8.0, P< 0.01).*

Sales & agent valuations:

- At weaning at average LWt of 20.5 kg = $40-45
- Abattoir killed lambs - sold @ $3.40/kg carcase + $2 skin. 43 unselected lambs averaged $69.51 gross and 54 selected lambs grossed $69.65/head.
- Residual at slaughter: 33kg Dorset x Merino at 10 months, mixed sex and shorn = $43-45

Dunkeld

Once split into pasture and irrigated feeding growth rates were used for comparison.

Trait	Lamb type	No.	Mean + se	P
Wn Wt	Selected	136	26.8 ± 0.4 ^{A}	
	Unselected	115	24.6 ± 0.4 ^{B}	
	2^{nd} X	76	31.9 ± 0.6 ^{C}	
Last wt together	Selected	130	28.7 ± 0.4 ^{A}	
(Day 140)	Unselected	113	25.3 ± 0.4 ^{B}	
	2^{nd} X	73	33.1 ± 0.6 ^{C}	
Past Kill	Selected	81	101.3 ± 3.0 ^{A}	<0.01
	Unselected	62	88.7 ± 3.0 ^{B}	
Fed Kill	Selected	45	146.1 ± 5.1	ns
	Unselected	46	137.3 ± 4.4	
Finish growth	Fed		123 g/day A	
	Past		91 g/day B	

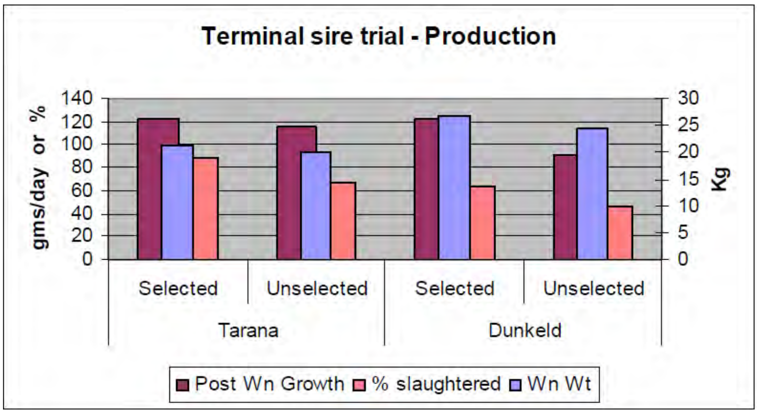
A higher proportion of pasture fed lambs sired by selected sires reached the target kill weight than did those sired by unselected rams (5 of 64 – 8% vs. 35 of 83 – 42%; X2 = 21.5,P< 0.001).

Sales & agent valuations:

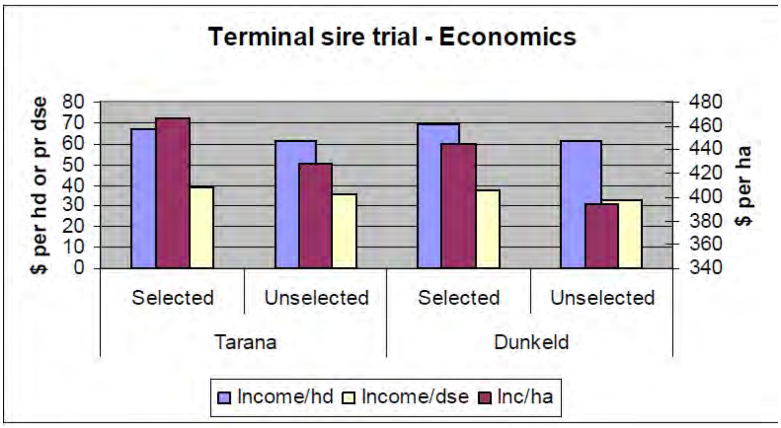
- At weaning 1st x achieved $26 and 2nd x achieved $44
- The pasture fed lambs making kill liveweight: these sold at $3.50/kg carcase weight, averaging $71.52 + $6.20 skin. Thus they achieved $77.72 gross x 40 head.
- The balance of pasture fed lambs sold at Bathurst saleyards. These sold for 33 at $74 and, 92 at $60/hd gross, less 10% costs.

- The irrigation lambs were all sold at Bathurst yards (Cowra had closed) as follows: 66 at $68 and 26 at $47.60/hd gross less 10% costs.

Combined results



Across the 2 trial sites the use of selected sires resulted in an average increase in returns of $6.72 per lamb (an 11% increase) compared to lambs from unselected sires). Assuming the farms were not fully stocked this represented an increase of $45 per ha or $3.72 per lamb DSE.



Ref 9b

In a crossbred lamb enterprise, the producer is likely to benefit if he or she selects terminal sires using genetic information targeted to the intended final lamb market. In this trial, the progeny of such selected sires grew substantially faster, finished earlier and produced higher returns both per head and per hectare than the progeny of visually selected terminal sires.

Across the 2 trial flocks, lambs sired by LAMBPLAN 'selected' sires compared to lambs sired by unselected sires:

- were 1.8 kg or 10% heavier at weaning,
- grew 20 g/day or 19% faster to slaughter,
- were 4.5 kg or 12% heavier at the time of first slaughter, and
- met slaughter specifications at the first kill at a higher proportion (20%)

The economic analysis conducted by Holmes & Sackett (***ref 9c***) raises the issue of the need to consider feed supply and running animals of greater live weights but also highlights the value of turning off lambs faster when feed supply is limited.

Number	10
Name	**South West Prime Lamb Group - Comparison of High & low EBV Sires**
Traits researched	EMD, growth WT
Date	2006-2007
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	MLA PIRD
Contact	Kate Joseph, 120 Josephs Road, TYRENDARRA 3285 VIC Ph: 03 5529 5329, M: 0417 735 507 E: primeag@westvic.com.au

Further Information

Permission	Yes
Summary of resources	Final report
File and format	**10a** 2005V03_south west prime lamb.pdf

Key Findings

- Selecting sires for extra growth using ASBVs results in higher sale weights.
- Using post weaning weight ASBV tends to overestimate the differences in actual weaning weight but is much closer to the differences recorded presale.
- Selecting sires for increased eye muscle depth results in lambs with increased eye muscle areas.

Useful Information

- Rams were chosen as 4 contrasting teams for post weaning growth and muscle EBVs. Each team of rams consisted of between 2 and 5 rams.
    - High Growth and High Muscle
    - High Growth and Low Muscle
    - Low Growth and High Muscle
    - Low Growth and Low Muscle

Background

The trial aimed to examine how to use Australian Sheep Breeding Values (formerly LAMBPLAN EBVs) to choose sires in order to maximize the commercial returns to members for prime lamb production. Those conducting the trial were particularly keen to look at the importance of growth and muscle ASBVs in terminal sires.

Rams were chosen as 4 contrasting teams for Post Weaning growth and muscle EBVs. Each team of rams consisted of between 2 to 5 rams.

- High Growth and High Muscle
- High Growth and Low Muscle
- Low Growth and High Muscle
- Low Growth and Low Muscle

Three farms each made available approximately 120 crossbred ewes for mating in February 2006. They were synchronized using Progestagen® sponges and naturally mated with selected groups of terminal sires over a period of one and a half days. The ewes were pregnancy scanned in April and those which had conceived in this synchronized mating were retained. When these ewes lambed, the lambs were tagged at birth and identified with their mothers and their litter size and sex were recorded. The ewes and lambs were grown out and the first weighing was in November 2006.

The lambs were weaned and grown on until the owners felt they were ready to slaughter. At this point, the lambs were weighed and ultrasound scanned (fat and muscle depth) and then sold. On one farm, the lambs were VIAscanned at slaughter. The final liveweights were taken between December 2006 and January 2007.

Results

The clear message for producers was that whether one uses rams with higher or lower ASBV does make a difference to what is produced but it is really important to select the right traits for the particular production system as some traits have more of an effect at different ages of the animal. If the intention is to turn off suckers, there is no point selecting for traits that will not reach their potential until the animal is more mature.

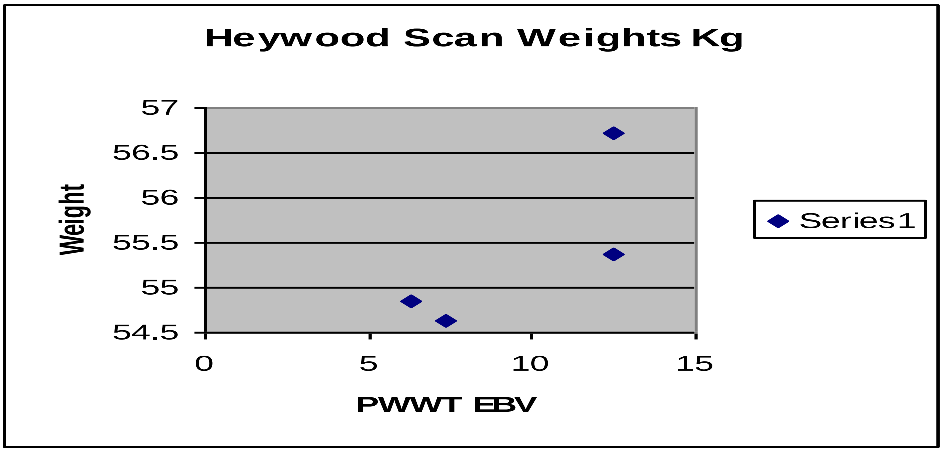
The message was that selection of rams using ASBVs for growth and muscling results in reasonably predictable progeny differences, which are worth money for the commercial lamb producer.

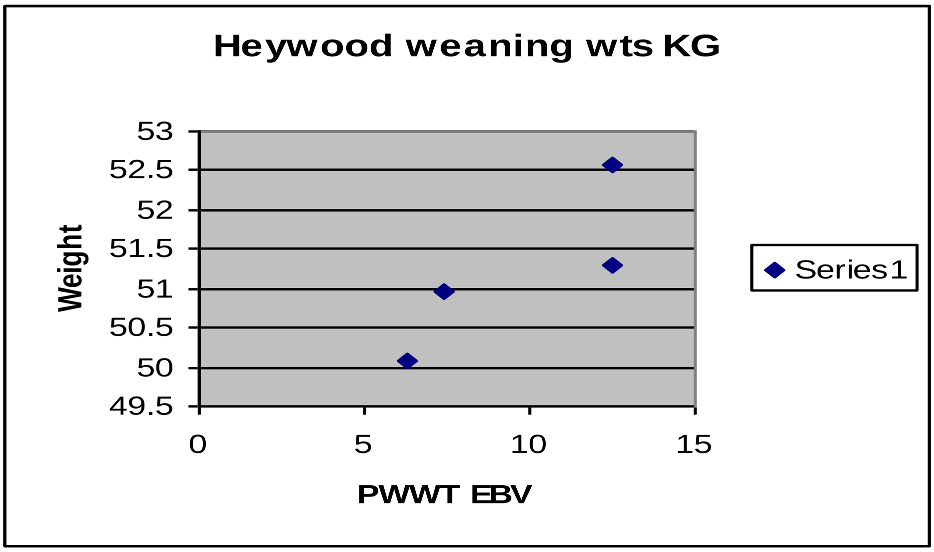
All six groups sired by High Growth EBV rams were heavier than those sired by Low Growth EBV sires and on each farm this difference was statistically significant - although there was quite a bit of variation between some of the teams. Averaged over the 3 farms, a difference of +6 Kg in PWT EBV resulted in difference of +1.7 Kg in pre-slaughter liveweight. The slaughter ages were about one month younger than the age used in the definition of Post Weaning for LAMBPLAN which may be a reason that the difference observed is slightly less than the 3Kg expected.

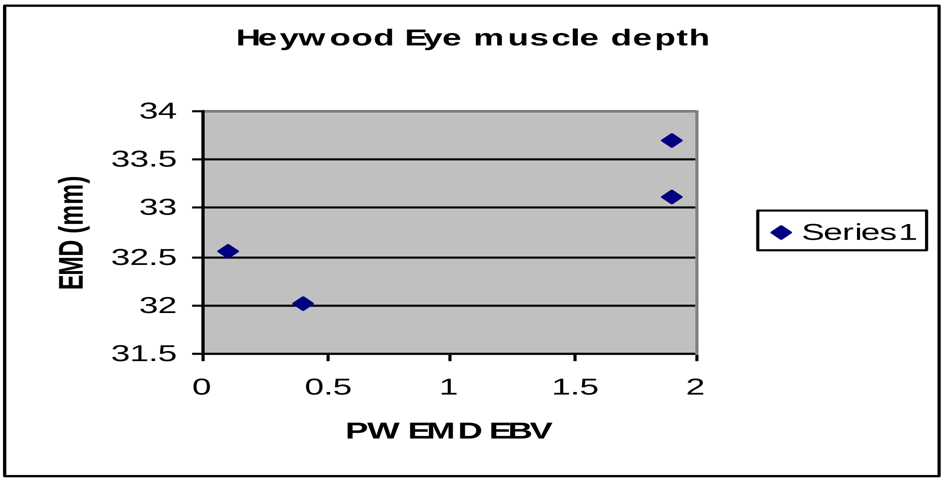
It is worth considering that 1.7 kg of extra liveweight should translate to about 0.8 extra kg of carcase weight. If this is valued at $3.50 per kg then each lamb is worth $2.80 more. If a ram sires 60 lambs per year and stays in service for 3 years then the value of the extra lamb sold is $504 during his lifetime. This of course is an oversimplification of the true situation but gives good indication of the importance of buying better rams.

Averaged over the 3 farms, wether lambs weighed 3 Kg more than ewe lambs and singles averaged 5 Kg more than twins.

The results for one of the three sites are reported here with full results across all sites in ***ref 10a***.


Heywood Scan Weights Kg
Weight
57
56.5
56
55.5
55
54.5
0
5
10
15
PWWT EBV
Series1


Heywood weaning wts KG
Weight
53
52.5
52
51.5
51
50.5
50
49.5
0
5
10
15
PWWT EBV
Series1


Heywood Eye muscle depth
EMD (mm)
34
33.5
33
32.5
32
31.5
0
0.5
1
1.5
2
PW EMD EBV
Series1

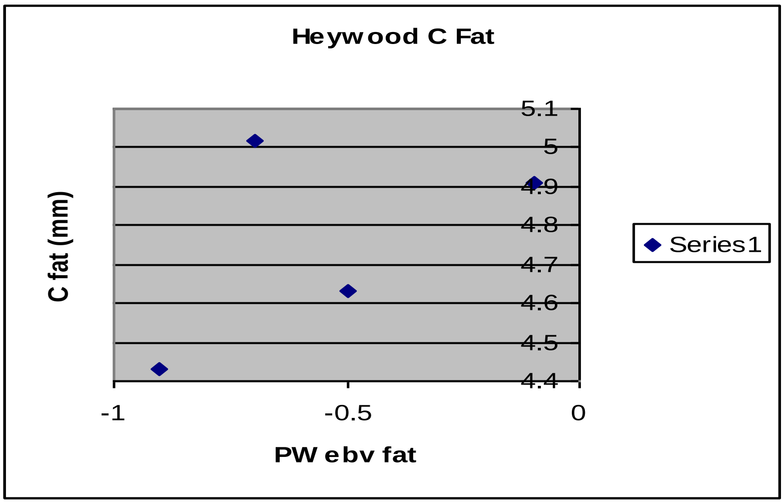


Table 1 Weaning Weights (Kg) from Heywood (n = 121)

Main Effects					difference	SED
Sex	E	49.57	W	52.88	-3.31	0.74
Birth Type	S	54.23	T	48.22	6.01	0.79
Growth	H	51.94	L	50.52	1.42	0.72
Interaction						
Muscle		H		L		
Growth	H	51.31		52.57	-1.26	
	L	50.95		50.09	0.86	
Difference		0.36		2.48		1.03
Average effect of Muscle		51.13		51.33		

SED = standard error of difference (very approximately differences have to be greater than SED x 2 to be statistically significant)
E = ewe, W = wether, S = single, T = twin, H = high and L = low.

Table 2 Scan Weights (Kg) from Heywood (n = 105)

Main Effects					difference	SED
Sex	E	54.04	W	56.73	-2.65	0.81
Birth Type	S	57.89	T	52.89	5.0	0.85
Growth	H	56.04	L	54.74	1.3	0.80
Interaction						
Muscle		H		L		
Growth	H	55.37		56.71	-1.34	
	L	54.62		54.85	-0.23	
Difference		0.75		1.86		1.15
Average effect of Muscle		55.00		55.78		

Number	11
Name	**Kangaroo Island Prime Lamb Evaluation Trial**
Traits researched	Growth
Date	1999
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	MLA PIRD
Contact	Richard and Sue Trethewey, Pardana Ph: 08 8559 4208

Further Information

Permission	Yes
Summary of resources	MLA Final Report and a summary report
File and format	**11a** *summary* KI prime lamb ram evaluation trial.pdf **11b** *also contains summary* KI prime lamb producer group final report.pdf

Key Findings

- This trial involved the comparison of high growth and medium growth Poll Dorset rams, defined with reference to LAMBPLAN EBVs (prior to development of ASBVs).
- Higher growth rams produce lambs worth more money and a greater portion of lambs reaching target market weight earlier.

Useful Information

- This was a small trial with two sites.
- One site had two high growth Poll Dorset rams and two medium growth Poll Dorset rams as well as two White Suffolk rams.
- The second site had four high growth and four medium growth Poll Dorset rams.
- All rams were joined to Merino ewes (309 ewes at site 1 and 440 at site 2).
- For the purposes of reporting, an assumed carcase value of $2/kg is used.

Background

The trial aimed to determine the benefit of using high versus lower growth LAMPLAN sires, defined by reference to their ASBVs. All rams were above average for their breed and the difference in EBV for growth was +1.7kg on site 1 (Kelly) and +2kg on site 2 (Trethewey).

LAMBPLAN theory is that a ram with an EBV of +1.0kg of growth with pass half that (0.5kg) onto his offspring. However, because this estimate is made at yearling age (about 60kg), and most offspring were sold at around 40kg we would only expect to get around two thirds, or 0.3kg difference in live weight.

Site 1 experienced poor conception rates in the White Suffolk group.

Results

Lambs sired by high EBV growth rams were heavier at the end of the trial, though at both sites the response was below that expected for the given EBV difference. The results confirm that higher ranking rams on LAMBPLAN will produce better lambs. The growth benefits from higher performing rams should continue for those producers carrying lambs over to finish and market at heavier weights during summer and autumn.

Kelly Site (site 1)

- Lambs born July/August 1999.
- A sample of 60 lambs for each Dorset group were tagged and subsequently monitored until the completion of the trial on the 7th of January 2000.
- There was 23 White Suffolk cross lambs tagged due to low (55%) conception rates
- All lambs were weaned and short on the 20th of December

Lamb performance - Kelly site.

	Medium Dorset:		High Dorset:		White Suffolk:	
	weight	fat	weight	fat	weight	fat
25/8/99	13.5	-	13.3	-	14.1	-
18/11/99	36.4	3.3	36.6	3.3	39.9	3.4
7/1/00	39.9	2.7	40.9	2.8	44.9	3.0

Overall growth rate (g/hd/day)	207	217	241
Percent of lambs 18kg carcass wt & over by 7/1/00	58%	69%	86%
Increase in carcass wt (kg)	-	0.45	2.3
Increase in profit per lamb.	-	$0.90	$4.60
Break even extra ram value	-	$180	$920

Note: - Increase in carcass wt is given above that of the lowest ram group.
- Increase in profit per lamb assumes a return of $2 a kg carcase weight, no change in skin value, and no change in the cost of production (eg. feed).
- Break-even extra ram value is the extra price for the rams that equals the extra return - assuming he sires 200 lambs in his life.

Trethewey site (site 2)

- Lambs born June/July 1999.
- A sample of 85 lambs from each group were tagged and reweighed at the end of the trial on the 12th of November.

Lamb performance - Trethewey site.

	Medium Index:		High Index:	
	weight	fat	weight	fat
27/8/99	20.7	-	21.3	-
12/11/99	41.5	3.2	42.4	3.3

Overall growth rate (g/hd/day)	270	274
Percent of lambs 18 kg carcass wt & over by 12/11/99	69%	73%
Increase in carcass weight (kg)	-	0.4
Increase in profit per lamb.	-	$0.80
Break even extra ram value	-	$160

Number	12
Name	**Woolsthorpe Prime Lamb Group PIRD**
Traits researched	Growth, fat, financial returns
Date	1995-1996
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	MLA PIRD and DPI Vic
Contact	Martin Dunstan DPI Vic, Ph: 03 5561 9903 E: martin.dunstan@dpi.vic.gov.au

Further Information

Permission	Yes
Summary of resources	Final report
File and format	**12a** Woolsthorpe prime lamb PIRD 1994.pdf **12b** Woolsthorpe and District Prime Lamb Group.pdf

Key Findings

- Even at trade weights, a $2.20/head advantage can be attributed to the use of high ranking LAMBPLAN rams compared with lower ranking rams.

Useful Information

- This was a sire selection demonstration at Willatook, Victoria, part of a larger project.
- 300 Romney-Corriedale ewes were joined to Texel-Poll Dorset rams.
- The trial involved a comparison of 4 rams selected from those with green dot (third quartile) EBVs based on the 60:20:20 index. These rams were compared to three top ranking rams on the 60:20:20 index, being rams in the top 25%, (blue dot).
- A carcase price of $2.30/kg is assumed.

Background

A mob of 300 Romney-Corriedale ewes was randomly split into two equal mobs for joining to Texel-Poll Dorset rams in late March. One mob of 150 ewes was joined to three of the top ranking 'blue dot' rams (i.e. from the top 25% of their year group). The other 150 ewes were joined to four average ranking green dot rams (i.e. from the 25% of the rams ranked third out of four of their year group). Rams were ranked using LAMBPLAN, on an index with a weighting of 60% for growth rate, 20% for leanness and 20% for eye muscle area. The two mobs were run together during pregnancy, and separated for the lambing to marking period (about 5 weeks).

The ewes lambed over a six-week period, beginning 20 August. Lambs were marked on September 28 and the two mobs of ewes and lambs were boxed in the same paddock after marking. The lambs were designated to be run as one mob until sale (as either suckers or weaned lambs), with feedback (carcase weight, fat score, and financial returns) to be obtained at slaughter in order to evaluate the difference in returns from the two groups of rams.

Results

The sire selection demonstration proved to be an outstanding success, despite being brought to an early finish by a very dry spring where it was conducted at Willatook. The lambs were originally destined to be carried into the autumn to be sold as heavyweights but, following assessment of the lambs and their pasture in December, and some predictions made with the help of Grazfeed, the producer decided to sell them into the strong pre-Christmas market. Even at trade weights, a $2.20/head advantage was realised by the progeny of high ranking LAMBPLAN rams.

The lambs were assessed as being in good condition, at the top end of the Fat Score 3 range in December. The lamb weights and Fat Score assessments at this stage have been used as the basis for comparison and financial evaluation. Based on the liveweight differences at this assessment, and using a carcase price of $2.30/kg, the Blue Dot lambs returned an extra $2.20/head at this age. Using comparative figures from this demonstration, the superior LAMBPLAN ranked rams (the 'Blue Dot' rams) could be expected to generate additional gross income of $484 over a four-year working life, when compared with the 'Green Dot' rams.

This is based on the assumption that each ram sires 55 marketable lambs per year, which are sold at trade weights. Improvement in gross income per ram could conceivably be greater when lambs are grown out to heavier weights.

Ref 12b

Table 1. **Comparison of lambs at 13-14 weeks old (Trade Weight carcases)**

	Lambs born to Blue Dot rams		**Lambs born to Green Dot rams**	
	Wethers	**Ewes**	**Wethers**	**Ewes**
Number of lambs assessed	84	87	74	82
Average Liveweight (kg)	38.4	34.6	35.7	33.5
Average GR Fat (mm) (Live assessment)	14	14	14	15
Estimated carcase weight (@48% dressing %)	18.4	16.6	17.1	16.1
Average Carcase Value (@$2.30/kg)	$42.39	$38.20	$39.41	$36.98
Average Carcase Value over both sexes (@$2.30/kg)	$40.30		$38.20	
Increase in Average Carcase Value due to Sire Selection	**$2.20**			

Number	13
Name	**NSW DPI LAMBPLAN Trial**
Traits researched	Growth
Date	1999
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	NSW DPI
Contact	Ashley White, NSW DPI Ph 02 6349 9727 E: ashley.white@industry.nsw.gov.au
What's missing	Further references

Further Information

Permission	Yes Farming Ahead articles have been reproduced with the permission of Kondinin Group and Farming Ahead.
Summary of resources	Article in Farming Ahead
File and format	**13a** NSW DPI Trial 1999.pdf

Key Findings

- High growth EBVs will produce lambs that grow faster and are more likely to meet specifications.

Useful Information

- 500 Border Leicester-Merino cross ewes were joined to 5 rams with superior genetic merit for growth and leanness ("high rams") when compared to their flock mates – and these rams were compared to 5 genetically inferior rams ("low rams").
- Trial using LAMBPLAN EBVs.

Background

When 500 second cross lambs were marked, a random half of males were castrated and half were made cryptorchids. All lambs were weaned at an average weight 26kg. Lambs were slaughtered in groups every 3-4 weeks when they reached a liveweight of 48kg (from 6-8 months of age). A minimum target weight of 48kg was chosen because lambs needed to reach at least this weight to ensure that most dress out at more than 22kg.

Sire EBVs

	High Rams	Low Rams
Average EBV for wt (kg)	+1.5	-0.8
Average EBV for fat (mm)	-0.5	+0.7
Index	110	90

Results

- 30% of all lambs sired by high rams reached specification (more than 48kg liveweight and a fat score of 2 or 3 by 8 months of age).
- Only 17% of all lambs by low rams met the specifications.
- At 6 months of age and 40kg liveweight, lambs sired by high rams were 2.1kg heavier than the lambs sired by low rams. This was above the 0.8 difference expected at 40kg.

Sire	Lamb Sex	Percentage of lambs meeting specification*
High rams	Cryptorchid	63%
Low rams	Cryptorchid	46%
High rams	Wether	34%
Low rams	Wether	10%
High rams	Ewe	14%
Low rams	Ewe	6%

*lambs not reaching the specifications were:

- lean enough but too light,
- too fat or too light, or
- heavy enough but too fat.

Number	14
Name	**Effects of Nutrition and EBVs for Growth and Muscling on the Development of Crossbred Lambs**
Traits researched	EMD, WWT, CFW, EMD, FAT, carcase traits
Date	2001-2002
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	NSW DPI and MLA
Contact	Dr Roger Hegarty E: rhegart3@une.edu.au

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	Paper
File and format	**14a** Hegarty RS, Shands C, Marchant R, Hopkins DL, Ball AJ, Harden S (2006) Effects of available nutrition and sire breeding values for growth and muscling on the development of crossbred lambs. 1: Growth and carcass characteristics. *Australian Journal of Agricultural Research* **57**, 593–603. Hegarty et al ajar 2006, 57, 593-603.pdf

Key Findings

- This was a study to appreciate genetic and nutritional interactions for lamb growth traits.
- EBVs performed as predicted however there was a need to provide optimised nutrition to lambs pre-weaning in order to maximise the production benefit from investment in sires with high EBVs for growth.
- There is no effect of nutrition on the lambs' expression of muscle development (PEMD): sires with high EMD EBVs produced progeny with high EMDs.
- Depth of fat at the C-site was positively associated with the EBV of the sire for fat depth.

Useful Information

- 394 first cross (BLxM) ewes were randomly joined to 9 Poll Dorset sires representing 3 sires of different sire types.
- Sire types differed in EBVs for PEMD and PWT as supplied by LAMBPLAN.
- Ewes were allocated to either a low or high plane of nutrition.

Background

The study was conducted to determine the effect of the level of available nutrition on the growth, development and carcase characteristics of lambs differing in their genetic potential for muscle development or differing in their genetic potential for rate of live weight gain.

The growth and development of 387 crossbred lamb progeny from 9 Poll Dorset sires representing muscle (M), control (C), and growth (G) sire-types was studied. Sires were selected on the basis of their LAMBPLAN estimated breeding values (EBVs) for post-weaning growth (PWT) and depth of loin muscle (PEMD). Lambs were provided with either LOW or HIGH levels of available grazing nutrition from 10 days of age onwards.

Results

Liveweight gain (LWG) throughout the study was less on LOW nutrition than on HIGH nutrition, leading to a 9.5 kg lower weaning liveweight (LW) and a 14.9 kg lower final LW in LOW lambs. After adjustment for final LW, HIGH lambs had significantly greater fat depth at the C-site (C-site is approximately 40mm from the midline over the 12th rib) and tissue depth at the GR site (GR site is approximately 110mm from the midline over the 12th rib) than did LOW lambs. This effect was consistent across sire-types. Depth of fat at the C-site was positively associated with the EBV of the sire for fat depth (see Table 4, Table 5 and Table 6 for results).

The improvement in pre-weaning LWG, weaning weight, and final weight of lambs resulting from use of sires with a greater PWT EBV was dependent upon the level of nutrition. This interaction was identified as different slopes (coefficients) for the regression between PWT and post weaning weight measured at the 2 nutrition levels, indicating that the expression of the sire's genetic potential for growth at these times was significantly moderated by nutrition.

The additional depth of lamb loin muscle resulting from use of sires of higher PEMD EBV was consistent across both LOW and HIGH nutrition treatments, with 1mm of PEMD leading to a 0.6-mm increase in loin depth. Other consequences of sires having a high genetic capacity for loin muscle depth were reduced carcase C-fat depth with increasing sire PEMD and a tendency for conformation score to improve with the PEMD of the sire.

The wool-growth response to improved nutrition was less in lambs sired by the muscle sire-type, than in lambs of other sire-types, suggesting a difference in priority for protein partitioning between muscle and wool in lambs differing in genetic propensity for muscle growth

Table 4. Growth parameters of crossbred lambs from sires selected to have high genetic merit for growth (G) or for muscle development (M) or growth and muscle typical of that found in the Australian lamb industry (C)

Lambs were reared on LOW or HIGH planes of nutrition from approximately 10 days of age. The significance of nutrition (N) and sire-type (ST) and their interaction are indicated

	LOW			HIGH			N	ST	N × ST	s.e.d.
	G	C	M	G	C	M				
Pre-weaning LWG	198.4	190.8	204.4	312.0	276.1	294.3	***	***	**	7.44
Weaning LW (kg)	23.4	22.6	23.7	34.3	30.5	32.2	***	***	*	0.749
Post-weaning LWG	92.4	75.1	76.1	132.1	114.8	115.8	***	***	n.s.	3.14
Final LW (kg)	36.62	33.92	35.04	54.08	47.15	49.06	***	***	***	0.0861
Fleece wt (kg)	1.273	1.282	1.291	1.813	1.811	1.697	***	n.s.	*	0.0538

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$; n.s., not significant ($P > 0.05$).

Table 5. Significant regression coefficients (± s.e.) between growth or carcass traits of lambs and the estimated breeding value (EBV) for growth, muscling (PEMD), or fat (PFAT) of the lamb's sire

Where coefficients were affected by nutrition (N), separate coefficients are provided for LOW and HIGH nutrition

Trait	Nutrition	Sire EBV					
		Growth (kg)		PEMD (mm)		PFAT[A] (mm)	
		Mean	s.e.	Mean	s.e.	Mean	s.e.
Prewean. LWG[B] (g/day)	LOW	0.626	0.749	−5.06	5.45	n.t.	
	HIGH	3.571	0.756	−5.06	5.45	n.t.	
Weaning LW[B] (kg)	LOW	0.078	0.074	−0.53	0.54	n.t.	
	HIGH	0.383	0.076	−0.53	0.54	n.t.	
Postwean. LWG[B] (g/day)		1.68	0.291	n.s.		n.t.	
Final wt[C] (kg)	LOW	0.275	0.086	0.585	0.161	n.t.	
	HIGH	0.683	0.088			n.t.	
Final EMD (mm)		n.s.		0.610	0.082	n.t.	
Final C-fat (mm)		n.s.		n.s.		0.209	0.09
Fleece wt[C] (kg)	LOW	n.s.		0.0064	0.0119	n.t.	
	HIGH			−0.0336	0.121	n.t.	
Carcass GR (mm)		−0.011	0.043	0.062	0.089	1.13	0.30
Carcass C-fat (mm)	LOW	n.s.		−0.136	0.055	0.12	0.29
	HIGH			−0.136	0.055	1.2	0.27
Carcass EUROP		n.s.		0.031	0.021	n.s.	

[A]Effects of PFAT were only tested on carcass traits considered related to fatness (n.s., not significant; n.t., not tested).
[B]WWT.
[C]PWWT.

Table 6. Live assessment, carcass characteristics, and meat descriptors in lamb progeny from sires selected to have high genetic merit for growth (G) or for muscle development (M) or growth and muscle potential typical of that found in the Australian lamb industry (C)

Lambs were reared on LOW or HIGH planes of nutrition from 10 days of age. All live traits are considered at a standard weaning or final liveweight and carcass traits are adjusted for HSCW. The significance of littersize, sex, and ewe age are indicated and described in the text

	Nutrition (N)				Sire-type (ST)					Interact.	Litter size	Sex	Ewe age
	Effect	LOW	HIGH	s.e.d.	Effect	G	C	M	s.e.d.				
					Live traits[A]								
Wean GR (mm)	n.s.	8.35	8.31	0.63	***	7.46	8.83	8.70	0.354	N × ST N × LW	*	***	n.s.
Final GR (mm)	***	9.56	16.04	0.39	n.s.	12.47	12.92	13.00	0.290	n.s.	n.s.	***	n.s.
Final EMD (mm)	***	22.36	26.54	0.45	***	24.17	23.67	25.52	0.307	n.s.	n.s.	*	n.s.
Final C-fat	***	3.21	4.80		**	3.72	4.22	4.07		n.s.	n.s.	*	**
			Carcass traits[B,C]							n.s.	n.s.		
C-fat (mm)	***	2.71	5.09	0.38	*	3.76	4.23	3.72	0.20	n.s.	n.s.	n.s.	n.s.
GR (mm)	***	10.39	16.53	0.78	**	12.85	13.58	13.95	0.328	n.s.	†	n.s.	*
EUROP	†	3.36	3.07	0.14	n.s.	3.17	3.17	3.30	0.073	N × HSCW	n.s.	n.s.	†
*L**	*	36.85	36.22	0.52	*	36.95	36.45	36.22	0.277	n.s.	n.s.	n.s.	n.s.
*a**	n.s.	20.5	20.4	0.46	n.s.	20.24	20.52	20.63	0.260	n.s.	n.s.	n.s.	n.s.
*b**	***	8.24	9.08	0.44	n.s.	8.54	8.75	8.68	0.206	N × HSCW	***	*	n.s.
Ultimate pH	*	5.57	5.55	0.03	n.s.	5.56	5.57	5.55	0.014	N × HSCW	n.s.	n.s.	n.s.

[A]Adjusted for liveweight.
[B]Adjusted for carcass weight.
[C]Meat colour of loin described as lightness (L^*), redness (a^*) and yellowness (b^*).
†$P < 0.10$; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$; n.s., not significant.

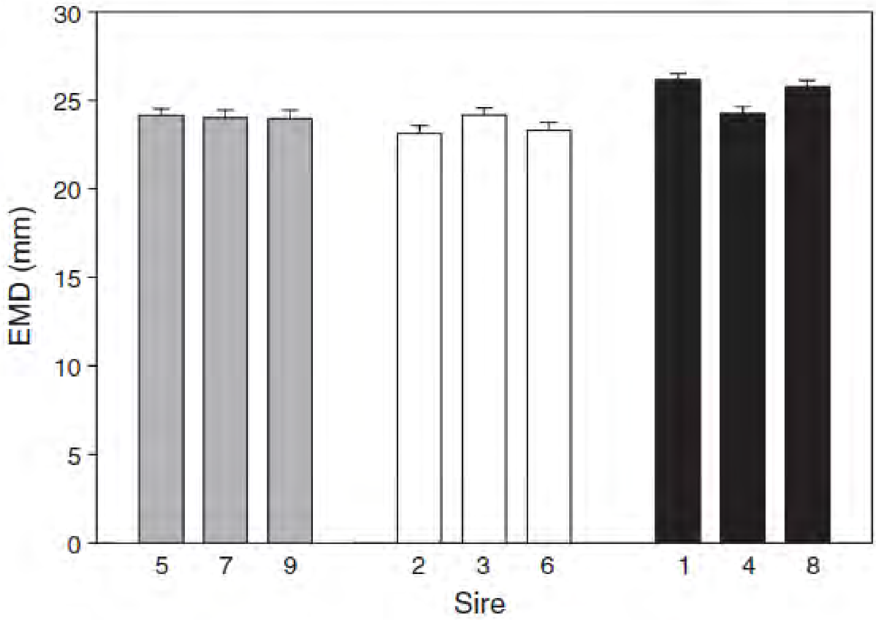


Fig. 2. Pre-slaughter loin muscle depth (EMD, mm ± s.e.) of lambs from sires selected for high genetic capacity for post-weaning weight (sires 5, 7, 9), high genetic capacity for muscle growth (sires 1, 4, 8), or selected to deliver industry standard growth and muscling potential (sires 2, 3, 6). Data are averaged over LOW and HIGH available nutrition levels and are adjusted for pre-slaughter liveweight.

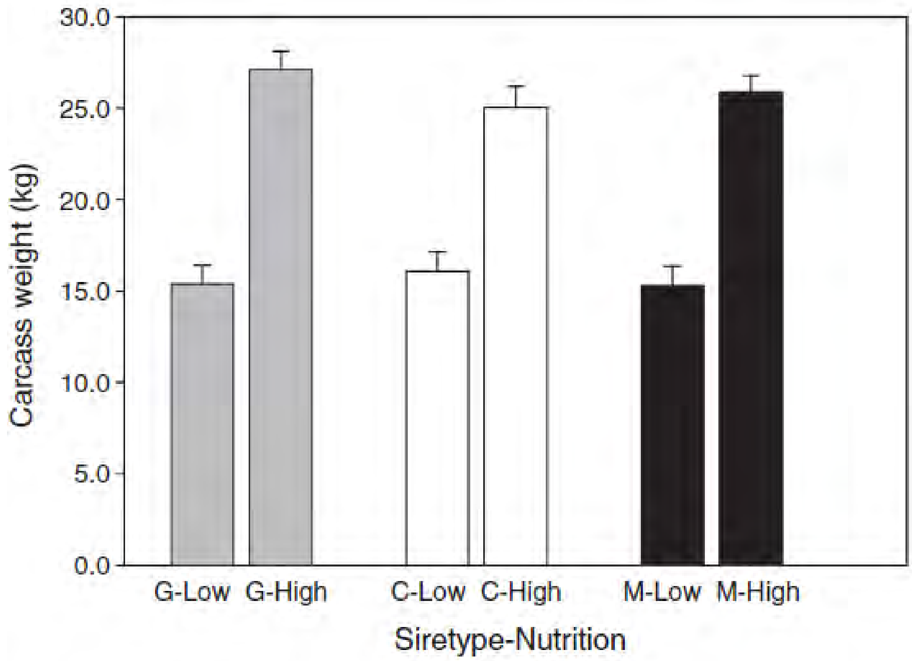


Fig. 4. Hot standard carcass weight (kg ± s.e.) of crossbred lambs from sires selected for high genetic potential for muscle development (M sire-type), or liveweight gain (G siretype) or having industry standard genetic potential for growth and muscle development (C sire-type) when reared on LOW or HIGH planes of nutrition.

Number	15
Name	**Terminal/Paternal Central Progeny Test**
Traits researched	Live weight, FAT, EMD, manual GR tissue depth, (live and carcase traits)
Date	1998/1999
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	DPI Vic, MLA
Contact	Gervaise Gaunt, Vic DPI, P: 02 6030 4571 E: gervaise.gaunt@dpi.vic.gov.au

Further Information

Permission	Yes
Summary of resources	Article for Poll Dorset Journal Two Rutherglen newsletters Summary from LAMBPLAN
File and format	**15a** PD JOURNAL 1999.pdf **15b** News99a.pdf **15c** News99b.pdf **15d** Background to LAMBPLAN CPT.pdf

Key Findings

- Sire progeny tests validate LAMBPLAN breeding values.
- At Rutherglen, commercial progeny data showed that each index point on the 60:20:20 index is worth up to $40 extra per sire lifetime.

Rutherglen Information

- 25 sires were each mated by AI to 32 first cross ewes (Border Leicester x Merino)
- 9 breeds were evaluated.
- All sires with available LAMBPLAN across-flock EBVs ranked highly within their breed and have performed well on the show circuit.
- Prices based on a 22 kg lamb, with a carcase price of $2.25 for lambs that meet fat and muscle specifications.

Background

Ref 15d

Terminal Sire Central Progeny Tests (TCPTs) assessed the genetic potential of sires used for meat production to produce heavy, lean lambs (carcase weight 22kg +, fat score 2-3). High performance LAMBPLAN sires were assessed under rigorous scientific conditions on experimental research institutes, following the measurement of their progeny for carcase attributes.

Terminal Sire Central Progeny Tests commenced in 1991 with over 400 sires representing 27 breeds tested nationally. There have been 21 TCPTs conducted at sites throughout Australia by State Departments of Agriculture, with funding assistance from the Meat Research Corporation and MLA LAMBPLAN.

The results from the TCPTs showed high correlations between across-flock LAMBPLAN EBVs and the performance of commercial lambs in weight, fat and muscle.

Rutherglen

Ref 15a

A sire intake at Agriculture Victoria - Rutherglen included 13 Poll Dorset sires drawn from a number of flocks and ranging in merit for the LAMBPLAN 60:20:20 index from 102 to over 170. Evaluation of the progeny of these rams was truly a test for the LAMBPLAN EBVs since these 13 sires all have LAMBPLAN across-Flock EBVs and index values.

Rutherglen Results

- Sires with higher EBVs for growth bred faster growing progeny: every 1 kg EBV for post weaning weight was worth an extra 2 g/day growth rate, from birth through to 200 days.
- Sires with lower EBVs for Fat bred leaner progeny: every 1 mm lower Fat EBV was worth 0.6 mm less GR depth.
- Sires with higher EBVs for muscle bred heavier-muscled progeny: every 1 mm extra EBV for eye muscle depth was worth 0.67 extra mm eye muscle depth at constant weight, and an extra 0.43 square cm eye muscle area at constant weight.

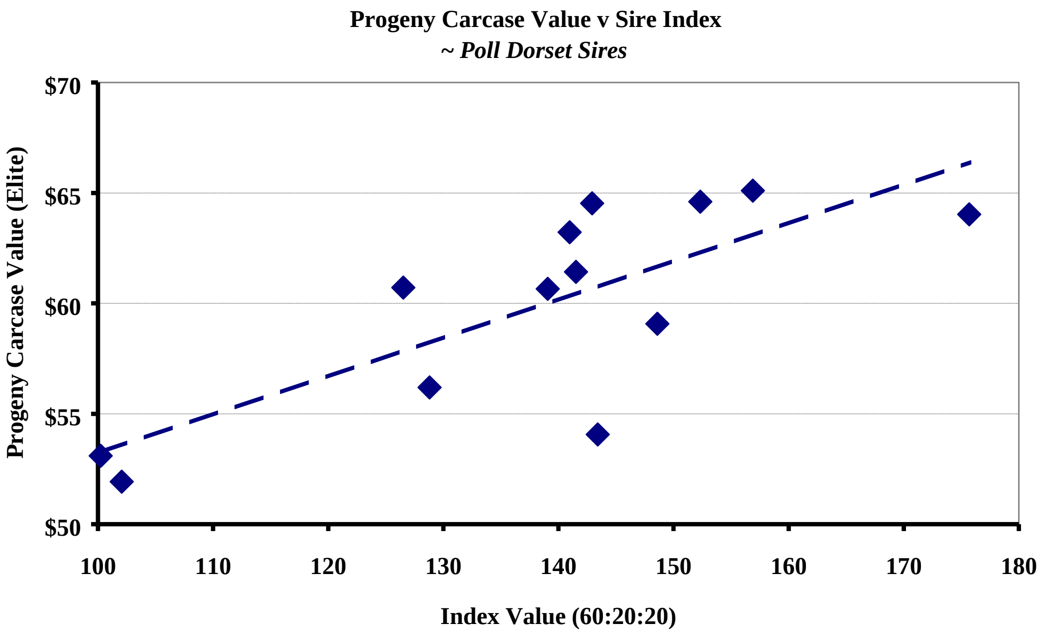
The LAMBPLAN across-flock EBVs for these sires predicted their cross-bred progeny performance very well.

What about other characteristics of the progeny?

- Each 1 index point extra (on the LAMBPLAN 60:20:20 Index) meant an extra 0.12 % dressing percentage: higher Index sires bred higher dressing percentage progeny.
- Sires with superior EBVs for weight and fat bred progeny that grew more lean meat at the same age.
- Each 1 index point extra meant an estimated $0.17 per lamb farm-gate in trade or elite lamb markets, or an extra $0.59 per lamb at retail.

The following chart shows the relationship between sire index value and progeny carcase value. (It should be remembered that the sires entered varied considerably in their data quality. Some of the spread in the chart is due to differences in the accuracy of the Sires' EBVs and index values because of differences in data quality).

- The progeny carcase value is the estimated over-the-hooks value per lamb at a constant age, so it rewards sires whose progeny have more valuable carcases and grow them faster. It is based on a 22 kg lamb, with a carcase price of $2.25 for lambs that meet fat and muscle specifications.
- The LAMBPLAN 60:20:20 index describes sires' genetic merit for a combination of growth rate and $ yield per kg carcase: the genetic ability to grow more quickly more lean meat in the higher value cuts.



On this basis each index point extra is worth an estimated $40 extra per sire lifetime.

Number	16
Name	**Meta-Analysis of Cross-Bred Progeny Data for Australian Terminal Sire Sheep**
Traits researched	PWT, PEMD, PFAT
Date	2009
Target audience	Ram breeders and buyers
Target	Meat and Maternal
Source	MLA
Contact	Robert Banks Ph: 02 6773 2425 E: rbanks@mla.com.au

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	AAABG Paper
File and format	**16a** Banks, R.G., Brown, D.J. and Field, S.R. (2009) Meta-Analysis of Cross-Bred Progeny Data for Australian Terminal Sire Sheep. *Proc. Assoc.Advmt. Anim. Breed. Genet*. 17:480. banks480.pdf

Key Findings

- In general, LAMBPLAN ASBVs predict progeny performance as expected.
- The study examined the relationship between the key traits recorded in LAMBPLAN (such as growth and carcase traits) and traits expressed in cross-bred commercial progeny.

Useful Information

- Data from 45 separate progeny tests were available, comprising 25,134 progeny of 257 sires.

Background

LAMBPLAN has been providing genetic evaluation services to the Australian lamb industry since 1988 (Banks 1990), and now analyses include data on approximately 105,000 new animals per year from 415 terminal sire breed flocks. The core traits analysed in LAMBPLAN remain growth rate, ultrasound fat depth and eye muscle depth measured on animals in the ram breeding sector, although there has been significant development in terms of stages of growth that can be analysed, as well as in the models for evaluation. In addition, there has been substantial genetic change in all 3 traits over the period 1989-present (Swan et al. 2009). The primary aim of LAMBPLAN remains to assist industry identify animals with superior merit for breeding fast-growing slaughter lambs with valuable carcases. This paper examines the relationship between the core LAMBPLAN genetic evaluation traits and traits expressed in cross-bred commercial progeny, by analysing sire-progeny regressions in a number of progeny tests conducted since 1990.

Results

This meta-analysis has shown that:

- for live weight and for carcase composition traits, regressions of cross-bred progeny performance on the corresponding sire trait LAMBPLAN breeding values are similar to expectations across a range of datasets collected between 1990 and 2008.
- the regression for carcase weight on sire post-weaning weight in these data is lower than anticipated, and as yet unexplained.
- there is considerable variation amongst the estimates across sites and years for all traits, which may be partly due simply to sampling effects, but also suggests that more detailed examination of factors affecting carcase weight is warranted.

Taken as a whole, these results suggest that lamb producers can confidently use LAMBPLAN breeding values to choose sires that will breed lambs with superior growth and carcase characteristics. The regression of progeny carcase weight on sire post weaning weight predicts the impact of that selection on processor and retailer returns, and the values for that regression estimated here suggest that further investigation of both the data and the analytical model should be conducted.

Table 1. Summary of the regression coefficients (se) across and within datasets

Sire Breeding Value	Progeny Trait	Regression Coefficients			
		All data, all sires	All data, only sires > 50% accuracy	Minimum value across datasets*	Maximum value across datasets*
Birth weight	Birth weight	0.45 (0.04)	0.52 (0.04)	0.06 (0.30)	0.99 (0.15)
Post-weaning live weight	Post-weaning live weight	0.37 (0.01)	0.36 (0.01)	- 0.24 (0.31)	1.09 (0.14)
Post-weaning live weight	Carcase weight	0.05 (0.01)	0.03 (0.01)	- 0.19 (0.18)	0.70 (0.09)
Post-weaning C fat**	Carcase GR Tissue depth**	1.96 (0.09)	1.94 (0.10)	- 0.96 (0.76)	3.22 (0.51)
Post-weaning eye muscle depth**	Carcase eye muscle depth	0.35 (0.02)	0.35 (0.03)	0.00 (0.21)	0.77 (0.11)

*only coefficients estimated from datasets with at least 15 progeny measured are included in this range
**trait is adjusted for constant weight (either live or carcase as appropriate)

Number	17
Name	**Establishment of Performance Testing for Meatsheep**
Traits researched	Growth, WT, FAT
Date	1980-1986
Target audience	Ram breeders and buyers
Target	Meat
Source	MLA
Contact	Richard Apps, MLA, Ph: 02 6773 3773 E: rapps@mla.com.au

Further Information

Permission	Yes
Summary of resources	MLA final report
File and format	**17a** Meat testing service - est of LAMPLAN.pdf

Key Findings

- This was an historic project that developed and implemented the NSW meat testing service in the 1980s - a precursor to LAMBPLAN.
- Used as a service model for national genetic improvement programs for meat sheep.

Useful Information

- This project saw the development of LAMBPLAN.
- It was based in NSW and supported by Department of Agriculture and former MLA entity.
- It provided a service to measure growth and fat depth, and analysis of the results.

Background

This project was undertaken to evaluate the development of a viable facility to enable meatsheep stud breeders objectively to test rams for genetic differences in growth rate and fat depth.

Within this broad objective, the project aimed to:

- develop recommendations and guidelines regarding the feasibility and practical design of a performance-testing scheme for meatsheep;
- develop and implement, in conjunction with the NSW meatsheep stud industry and the NSW Meatsheep Testing Service, to provide a model scheme for other organisations; and
- provide a large industry data base on Australian meatsheep breeds to give a sound technical basis for operational guidelines, adjustment procedures, parameter estimates and development of recommended breeding programs.

To achieve these objectives the project involved four components which included:

- the development (through software and processing technology and advisory programs) of the Meatsheep Testing Service and its implementation and promotion in N.S.W;
- evaluation of devices for measuring fat depth in live animals;
- accumulation of a large industry based data set and its analysis to provide estimates of genetic parameters and environmental effects for Australian meatsheep flocks; and
- Defining a model for development of performance recording nationally for the meatsheep industry.

The NSW Meatsheep Testing Service (MTS) allowed breeders to use objective measurement of growth rate and fat depth (adjusted for non-genetic effects) as an aid to their selections and sales. It was strongly supported by the industry and breed societies since its commencement in 1980 with 17,000 sheep tested annually from over 120 studs representing 13 breeds.

The project was undertaken by the NSW Department of Agriculture with the financial support of the AMLRDC to evaluate the development of a viable facility to enable meatsheep breeders objectively to test rams for growth rate and fat depth. This was achieved through Project DAN 23S and has greatly assisted the adoption of objective measurement of growth and fat by meatsheep studs and its increasing use in selection and ram marketing activities. Continued long term genetic improvement in the lamb industry has been significantly enhanced.

Results

As a result of the project, the proportion of terminal meatsheep rams sold annually in NSW which were tested for growth rate and fat depth increased to almost 50%. Almost half of all NSW lamb carcases were sired by MTS tested rams.

The success of the service was attributed to many factors including the co-operation and involvement of the industry in design and implementation, simplicity of output reports, quality control and associated strong advisory support plus the high level of technical backup and monitoring provided.

The large and unique data base comprised 28,000 Poll Dorset records from 50 flocks, representing 498 sires. It established heritability estimates of 0.30 for yearling growth rate (adjusted for differences in age, type of birth and rearing status and age of dam} and 0.35 for fat depth (adjusted for liveweight).

Analyses provided estimates of environmental effects and genetic parameters that previously did not exist for these Australian meatsheep breeds. This allowed more efficient adjustments to be made and provided the parameters necessary for estimation of breeding values and the development of selection indices.

Table 3.1.1 shows the number of sheep tested, number of studs, and average number of sheep tested per stud for the six years to 30 June 1986 and the subsequent year (1986/87) after funding from AMLRDC concluded. The slight decline in the number of studs and sheep being tested in 1986/87 was due to the necessity to charge a fee for the service after funding support ceased.

Table 3.1.1 Annual usage of the Meatsheep Testing Service

YEAR	SHEEP TESTED	STUDS	SHEEP/STUD
1980/81	1412	12	118
1981/82	7796	62	126
1982/83	9947	69	144
1983/84	13640	100	136
1984/85	17091	123	139
1985/86	17941	121	148
1986/87	16276	112	145

Fig. 3.1.3. Sample Meatsheep Testing Service Computer Report

FLOCK SUMMARY

NUMBER TESTED	49
AVERAGE GROWTH RATE	198.6 G/DAY
AVERAGE FAT DEPTH	3.9 MM PER 60 KG

Fig. 3.1.4 Sample Meatsheep Testing Service Computer Report

SIRE SUMMARY

SIRE GROUP	NUMBER TESTED	AVERAGE GROWTH	AVERAGE FAT DEPTH
295.83	16	102.4%	3.8mm
315.83	16	96.2%	3.8mm
452.84	17	101.3%	4.1mm

Number	18
Name	**Barwon Prime Lamb Group PIRD**
Traits researched	WT, EMD, FAT, HSCW, Carcase Value
Date	January 2001 – May 2002
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	DPI Vic, MLA PIRD
Contact	Martin Dunstan DPI Vic, Ph: 03 5561 990 E: martin.dunstan@dpi.vic.gov.au

Further Information

Permission	Yes
Summary of resources	Final report
File and format	**18a** 99VO2BarwonPIRD.pdf

Key Findings

- Selecting rams based on desired EBV is successful.
- The extra lifetime income received per high index ram was $1,244 in this demonstration. If all lambs were sold at $2.80/kg carcase wt, then the extra lifetime income received would be $806.
- Every little improvement helps the farmer produce a greater profit margin. Relatively small gains in lamb liveweight from using high index rams translate to substantially greater profit.

Useful Information

- The ewes were 2-year old Border Leicester×Merinos ewes.
- Two groups of 3 Poll Dorset rams selected for either high or slightly below average LAMBPLAN Carcase Plus index figures.
- Carcases were valued according to weight range, with a severe 100 c/kg penalty on carcases weighing <19 kg, and a 20c/kg premium on carcases weighing >24 kg. Hot Carcase Weight prices received were 170 c/kg (<19 kg), 270 c/kg (19 – 23.9 kg) and 290 c/kg (24 kg+).
- Relevant Estimated Breeding Values for the Carcase Plus Index are presented (Table 1).

Table 1. Estimated breeding values, Index rating and price of the rams used

Ram I.D.	PWWT (post weaning weight)	PFAT (post weaning fat)	PEMD (post weaning eye muscle depth)	Index Carcase Plus	Price $
	Estimated Breeding Values*			**Index**	
		Low Index Rams			
81	+ 2.34	0.00	0.00	114.18	400
83	+ 3.62	0.00	- 0.21	119.63	450
196	+ 1.86	+ 0.07	+ 0.57	115.90	450
Average	+ 2.61	+ 0.02	+ 0.26	116.57	433
		High Index Rams			
227	+ 9.33	- 0.27	+ 1.26	173.60	700
244	+ 10.24	- 0.75	+ 1.06	185.19	700
295	+ 8.81	- 0.61	+ 1.18	174.45	650
Average	+ 9.46	- 0.54	+ 1.17	177.75	683
		Average of all breeds tested in 1999#			
	+ 4.03	- 0.29	+ 0.16	130.76	-

*The EBVs refer to post weaning age.

#The average of the tested 1999-drop terminal sire breed animals, for comparison.

Note: Ram 83 died on 20 March as the rams were shifted out of the paddock after joining. The suspected cause of death was a heart attack. Ram 81 died on 9 December of unidentified illness.

Background

LAMBPLAN is a program that enables prime lamb producers to identify and use animals with the greatest genetic merit to breed lambs that will return greater profit. Whilst there is plenty of information available about LAMBPLAN, adoption rates will improve once producers are convinced that the advertised benefits do translate into greater profitability. This demonstration was conducted to confirm the benefits of selecting rams based on LAMBPLAN figures.

Results

Table 4. Lamb liveweight (kg) and numbers in the first slaughter draft on 14 December 2001

Progeny Group	**Liveweight (kg)** 26 Sep 01	**29 Nov 01**	No. lambs killed*	% lambs killed
High index rams (range)	33.1 (21.0-40.8)	46.3 (37.0-56.5)	150	75
Low index rams (range)	31.7 (19.6-43.8)	45.3 (35.2-60.5)	154	79

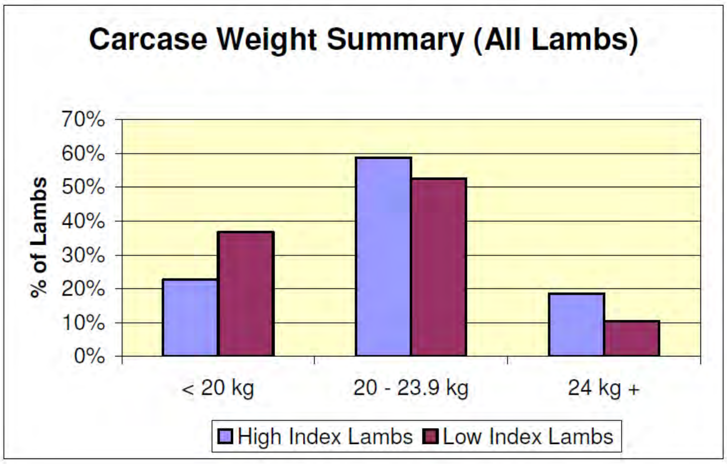
*

High index lambs averaged 0.8 kg carcase weight heavier than low index lambs for this kill.

2nd Draft – June 2002

Remaining lambs were monitored over the January – June period, during which time the remaining high index lambs maintained a 3.0 – 3.5 kg live weight advantage over the low index group. With the exception of a few lambs sold without feedback in May to complete another draft of sale lambs, all remaining lambs (20% of mob) were sold to Safeway and slaughtered at M.C. Herd. (Geelong), on 18th June. ***High index lambs averaged 1.3 kg carcase weight heavier*** than low Index lambs for this kill.

The graph below shows the distribution of carcase weights for all lambs (both drafts), broken down into Trade (<20 kg), Heavy Trade (20 – 23.9 kg) and Export (24 kg+).



Carcase Value

1st Draft – Tatiara Meat Company.

Carcases were valued according to weight range, with a severe 100 c/kg penalty on carcases weighing <19 kg, and a 20c/kg premium on carcases weighing >24 kg. Hot carcase weight prices received were 170 c/kg (<19 kg), 270 c/kg (19 – 23.9 kg) and 290 c/kg (24 kg+). A significantly greater percentage of low index carcases fell into the <19 kg class, incurring a substantial financial penalty. In addition, more high index lambs fell into the >24 kg class, receiving the 20 c/kg bonus.

These premiums and discounts, together with the average 0.8 kg carcase weight increase for the high index group, resulted in an average carcase value increase of over $4/head for the high index lambs.

2nd Draft – Safeway.

Carcases received a flat price of 330 c/kg hot carcase weight, regardless of weight class. The high index lambs produced carcases that were 1.3 kg heavier, again returning over $4/head more than the low index lambs.

Over the two drafts of lambs for which feedback was collected, the high index lambs returned an extra $4.32/head in carcase value.

VIAscan feedback: For the first draft of lambs slaughtered at Tatiara Meat Company, an estimate of lean meat yield (as a percentage of carcase weight) was provided for each progeny group. These results indicate that the high index progeny produced a slightly lower estimated lean meat yield percentage than the low index progeny. This result is consistent with expectations because heavier lambs yield less on a percentage basis. If the lambs were the same weight at slaughter, a similar lean meat yield percentage would be expected.

Were expectations realised from the high index rams?

What difference was expected? This can be calculated from the difference between the average post weaning weight (PWT) EBV for each ram group (see Table 2). The average potential difference in PWT EBV is 9.46 – 2.61 = 6.85 kg.

Because 50% of the lambs genes come from the ewe, only half of the ram's genetic potential is passed from the ram to the lamb. So one could expect the lambs from the high index rams to be around 3.4 kg heavier at around 8 months of age. The potential HSCW gain can be calculated by multiplying this 3.4 kg gain by the expected dressing percentage. For fat score 3 lambs slaughtered at Tatiara, dressing at 43%, the extra HSCW would be approximately 1.5 kg.

In this demonstration, the high index lambs averaged 1.0 kg heavier over the two drafts. This is lower than the anticipated 1.5 kg, but still results in productivity and financial gain from using the high index rams. The most likely reason for the lower than anticipated differences in lamb carcase weight is the early slaughter date for the first draft lambs (at 6 months of age). These lambs had insufficient time to express the full extent of their predicted post-weaning liveweight difference. Sub-optimal nutrition may also have contributed to this result. The lambs averaged a growth rate of around 250 g/day from birth to 1st draft, and the remaining 2nd draft lambs grew slowly, at around 65 g/day, between December and June.

Profitability

Using returns achieved in this demonstration

The lambs from the high index rams were worth an extra $4.32 per head on average.

Making some assumptions, the extra returns from purchasing the high index ram can be calculated as follows:

The ram is joined to 60 ewes per year @ 120% weaning over a 4 year working life with an extra $4.32 income per lamb = $1,244 extra income of a high versus low index ram. The average cost of the high index rams was $683, compared with $433 for the low index rams, a difference of $250. The additional net return from the high index ram compared with the low index ram is:

Extra income ($1,244) less the extra cost of the ram ($250) = $994 extra profit

A more conservative profit calculation

Disregarding any bonus related to meeting a specific carcase weight target (a factor which contributed to the $4.32 advantage achieved in this demonstration), carcases may be valued using a flat price, of say $2.80/kg.

Re-working the above calculation:

The ram is joined to 60 ewes per year @ 120% weaning over a 4 year working life with an extra 1 kg carcase weight per lamb valued at $2.80/kg = $806 extra income of a high versus low index ram In this case, the additional net return from the high index ram compared with the low index ram is:

Extra income ($806) less the extra cost of the ram ($250) = $556 extra profit

This still represents a 220% return on the extra money invested in the high index ram.

Number	19
Name	**Western Plains Prime Lamb Group PIRD**
Traits researched	WT, EMD, FAT, HSCW, Carcase Value
Date	April 1999 – August 2000
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	DPI Vic, MLA PIRD
Contact	Martin Dunstan, DPI Vic, Ph: 03 5561 9903 E: martin.dunstan@dpi.vic.gov.au D. & M. Evans, I. & N. Evans, “Mullumbimby”, Derrinallum, VIC 3325. Ph. (03) 5597 9249

Further Information

Permission	Yes
Summary of resources	Final report and presentation
File and format	**19a** 99V11 western plains pird report.pdf **19b** 9V11Western PIRD DemoOverheads.pdf

Key Findings

- This project validated LAMBPLAN as it applies to selection for muscling (conformation).
- Regrettably, a full comparison of results was not available due to a VIAscan failure.
- Although all the lambs did not get the VIAscan measurements, from the results that were obtained there was a 2kg live weight gain in the high muscled group and 0.8kg dressed weight increase in the high muscled group.

Useful Information

- Co-operators D. & M. Evans, I. & N. Evans, “Mullumbimby”, Derrinallum, VIC 3325. Ph. 03 5597 9249.
- Approximately 450 Finn/East Friesian/CBK maiden ewes joined to two groups of PLG White Suffolk rams.
- Ewes were drafted randomly into two equal groups, branded and ear-tagged, and joined separately, with one group being joined to high index rams and one to low index rams (60:20:20 index)

- High index rams averaged 125.38 compared to 109.79 for the low index rams (index values as per EBV figures from LAMBPLAN, August 2000).
- Major difference in index values of the two groups of rams was due to a greater EBV for muscling (YEMD), while EBVs for growth (YWT) and fat (YFAT) were held as near as possible to equal for each group.
- The lambs were run together from marking (2 months after start of lambing) until slaughter. The lambs were weaned when the oldest were 17 weeks old, and then finished on pasture (2 weeks), turnips (14 weeks) and feedlot (17 weeks). The extensive period on feedlot rations was necessary because the dry seasonal conditions produced a very poor turnip crop, and the aim was to attain a minimum 22 kg carcase weight for slaughter. (There were some feedlot ration issues which impacted on overall liveweights – see ***ref 19a*** for more detail)
- Lambs were slaughtered at Castricum Bros, Dandenong. It had been planned to use Viascan data but this was unavailable.

Background

Ram EBVs - April 1999 LAMBPLAN figures (as at joining):

Ram No.	YWT	YFAT	YEMD	INDEX
High index rams				
Average:	2.46	-0.25	1.37	134.4
Low index rams				
Average:	1.77	-0.40	-0.20	110.2

10 August 2000 LAMBPLAN figures (more accurate than April '99 EBVs):

Ram No.	YWT	YFAT	YEMD	INDEX
High index rams				
Average:	1.644	-0.08	0.972	125.38
Low index rams				
Average:	0.856	-0.944	-0.194	109.79

Results

When the lambs were approximately 8 months of age, the tail end of the mob was sold (30 high index lambs and 50 low index lambs).

Lambs were weighed and fat scored prior to slaughter at 11 months of age.

		Low	High
Liveweight (kg)		54.7	56.6
Fat Score	2	13%	4%
	3	60%	54%
	4	26%	41%
	5	1%	2%

SASTEK Slaughter Feedback

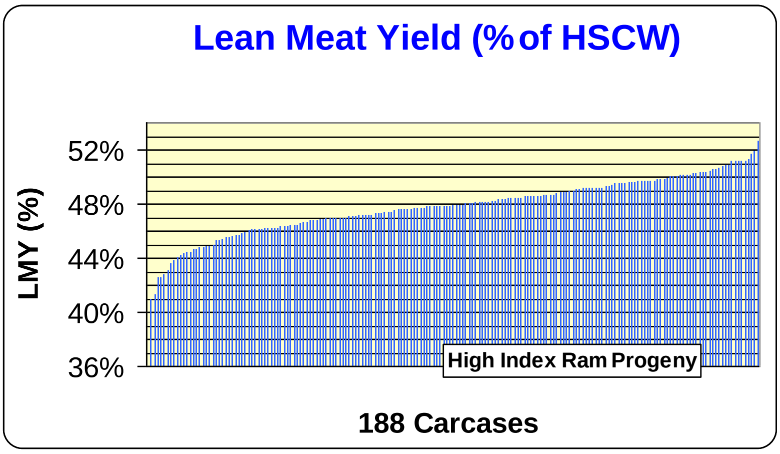
		Low	High
Carcase Weight (kg)		21.9	22.7
Dressing %		40.1	40.1
Fat Score	1	1%	5%
	2	19%	4%
	3	52%	32%
	4	25%	41%
	5	1%	19%

Carcase Weight Summary

Low Index		**High Index**	
Grade	%	Grade	%
<20 kg	27%	<20 kg	19%
20 – 20.9 kg	13%	20 – 20.9 kg	8%
21 – 23.9 kg	36%	21 – 23.9 kg	42%
24 kg +	23%	24 kg +	30%

VIAscan results were not available for the low index line so differences in EMD and true FAT were not established. Results for lean meat yield in the high index line are provided and highlight that there is a range in performance for lean meat yield which offers a scope for improvement.

Ref 19b Variation in progeny from high index rams for lean meat yield



Number	20
Name	**Project MAXEM - PIRD**
Traits researched	Growth, PWT, EMD, FAT
Date	2000
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	MLA PIRD
Contact	Dr Sarah Wiese. Ph: 08 9885 9050 E: wiese@activ8.net.au

Further Information

Permission	Yes
Summary of resources	Final report from MLA
File and format	**20a** 2000W02 MAXEM.pdf

Key Findings:

- PIRD designed to assess EBVs for EMD and impact on carcase meat yield.
- High muscle sires produced lamb with significantly higher eye muscle depth than low muscle sires. The 1.56 mm difference was even greater than the difference predicted by LAMPBLAN of 1.056mm.
- The trial produced some good results but it is recommended that the full report is reviewed prior to using this information.

Useful Information

- Project Maxem, PIRD was undertaken by the Poll Dorset Association, WA Branch.
- The project was designed to assess the role of the EBVs for Eye Muscle Depth (EMD) and the impact this has on maximizing carcase lean meat yield and ultimately maximizing returns to the producer.
- It was carried out on two properties –Shackleton in the north and Broomehill in the south.
- It was conducted by commercial producers in a Mediterranean type environment with sucker lamb turnoff usually being from August through to November.
- Merino ewes were mated to Poll Dorset rams, two groups of rams with +1 for EMD and two with -1, providing two high and two low mating groups on each site. The resulting progeny were assessed for lean meat yield.
- There were a few challenges with the trial due to disease and inability to obtain VIAscan data.

Background

Ram EBVs – minimum 50% accuracy. Due to a disease outbreak, rams used at Shackleton may have been infected with brucellosis, and the selection of rams for Broomehill was made later and from a reduced gene pool.

RAM ID	PWT	PFAT	PEMD	Carcase +
Shackleton - High				
1618381999990239	5.590	-0.102	1.228	147.10
1618901999992001	4.167	-0.096	1.077	137.74
1619721999990421	3.466	-0.735	0.860	141.95
1601851999990318	4.642	-0.379	1.252	150.45
AVERAGE	**4.466**	**-0.328**	**1.104**	**144.31**
Shackleton - Low				
1618381999990089	6.270	-1.122	-1.307	143.26
1618381999990162	6.918	-0.957	-1.021	147.34
1601851999990266	5.037	-0.957	-0.959	136.86
1641301999990050	6.023	-1.209	-1.482	141.44
AVERAGE	**6.062**	**-1.065**	**-1.192**	**142.22**
Replacement ram				
1601851999990304	4.557	-0.921	-0.667	136.09
Broomehill - High				
1618381999990227	4.194	-0.012	1.209	137.79
1618381999990237	4.223	0.171	1.032	133.17
1639431999990005	3.767	-0.219	0.792	134.47
1639431999990108	3.971	-0.036	1.04	135.18
AVERAGE	**4.036**	**-0.024**	**1.018**	**135.15**
Broomehill - Low				
1618921999990020	4.936	0.027	0.780	121.42
1618921999990017	4.154	-0.198	-1.168	116.49
1618921999990057	4.166	-0.213	-1.908	109.27
1618921999990351	5.318	-0.777	-1.405	130.76
AVERAGE	**4.643**	**-0.290**	**-1.315**	**119.48**

Lamb slaughters - Shackleton

Lambs were slaughtered in drafts as they reached commercial slaughter weights. The first draft of lambs from the Shackleton site was selected on the basis of a liveweight of 41 kg and above for the ewes and 41 to 45 kg for the wethers. Lambs slaughtered at WAMMCO International, Katanning on the 11 October. These 132 lambs were not consigned in treatment groups and no information was recorded at slaughter.

The wether lambs weighing 45 kg and above on the 9 October were not consigned immediately for slaughter, but were instead marked and returned to the paddock for a further week before being slaughtered at Hillside Meats, Narrogin on the 17 October. At slaughter, these 87 lambs were individually identified and the hot standard carcase weight and GR tissue depth recorded for each animal. Carcases were then followed through to the boning room where the retail meat yields of the leg, loin and rack cuts were recorded.

The remaining lambs were weighed on 22 October and all lambs 39 kg or greater made up the third draft of lambs. These 61 lambs were drafted into high and low groups and consigned as two lines for slaughter at WAMMCO International, Katanning on the 24 October. Information on the slaughter was obtained from the kill sheets of the two lines. Only 23 lightweight lambs remained from the trial lambs at this point and monitoring was concluded.

Lamb slaughters – Broomehill

The first draft of lambs from the Broomehill site was selected on the basis of a liveweight of 40 kg or greater on 22 November and were slaughtered at Hillside Meats, Narrogin on the 14 December. At slaughter, these 93 lambs were individually identified and the hot standard carcase weight and GR tissue depth recorded for each animal. Carcases were then followed through to the boning room where the retail meat yields of the leg, loin and rack cuts were recorded.

No other drafts of lambs were consigned to slaughter. On the 7 May 2002, 270 lambs were sent to the Katanning saleyards and 45 ewe lambs were consigned directly to the Ferez live export company. Lambs were not consigned in treatment groups and no liveweight information was recorded prior to sale.

Results

Date weighed	High EMD group			Low EMD group			Difference
	Mean	SE	No. lambs	Mean	SE	No. lambs	
Shackleton							
21 June	16.0	0.25	167	15.5	0.28	135	+0.5
25 July	21.5	0.33	167	21.5	0.36	134	0.0
6 Sept	32.2	0.34	167	31.9	0.38	133	+0.3
9 Oct	43.5	0.48	129	42.7	0.52	109	+0.8
Broomehill							
10 Aug	12.4	0.24	215	12.1	0.24	213	+0.3
18 Sept	23.7	0.31	215	23.1	0.32	209	+0.6
18 Oct	32.3	0.38	214	31.5	0.38	209	+0.8
22 Nov	38.2	0.37	213	37.5	0.38	207	+0.7

As an average for the whole period, the difference in growth rates between the low and high groups was negligible at 2 and 4 g/head/day for Shackleton and Broomehill, respectively.

Growth period	High EMD group			Low EMD group			Difference
	Mean	SE	No. lambs	Mean	SE	No. lambs	
Shackleton							
21/6 – 25/7	161	5.3	166	171	6.0	132	-10
25/7 – 6/9	248	4.2	166	244	4.8	132	+4
6/9 – 9/10	348	8.0	130	333	8.7	110	+15
21/6 – 9/10	250	3.1	130	248	3.3	110	+2
Broomehill							
10/8 – 18/9	288	3.5	215	279	3.5	209	+9
18/9 – 18/10	289	5.2	214	279	5.2	209	+10
18/10–22/11	166	4.6	213	172	4.6	206	-6
10/8 – 22/11	247	2.1	213	243	2.1	206	+4

Broomehill – 22 Nov	High EMD		Low EMD		Difference
	Mean	SE	Mean	SE	
Number of lambs	142		134		
Liveweight at scanning	41.0	0.32	40.7	0.33	+0.3
Eye muscle depth	23.17	0.13	21.61	0.13	+1.56*
GR fat depth	4.02	0.06	3.94	0.07	+0.08

* Indicates a significant difference between groups ($P < 0.05$)

Liveweight at scanning was a significant co-variate for both eye muscle depth and GR fat depth and so the eye muscle and fat depth measurements have been adjusted to a standard liveweight of 40.85 kg. Sex was a significant co-variate for liveweight at scanning, but was not significant for eye muscle depth or GR fat depth

This difference in eye muscle depth is in excess of that predicted by LAMBPLAN but does demonstrate that differences in a sires EBV for eye muscle depth are passed on as measurable differences in his progeny. Based on the difference between the sire post weaning EBVs for eye muscle depth of 2.333 mm, the predicted difference between groups for the 40.85 kg progeny was a 1.059 mm difference in eye muscle depth.

Second slaughter - Shackleton

More lambs from the high group than the low group made the 45 kg liveweight cut off and were consigned to slaughter in this draft of heavy wether lambs. As there were more high lambs than low lambs marked, the difference between groups as a percentage of the lambs marked was only 2.6% (30% of the high group versus 27.4% of the low group).

Shackleton – 17 Oct	High EMD		Low EMD		Difference
	Mean	SE	Mean	SE	
Number lambs	50		37		+13
Final liveweight (kg)	48.1	0.50	47.7	0.53	+0.4
Carcase weight (kg)	22.3	0.24	21.7	0.28	+0.6
GR tissue depth (mm)	11.8	0.36	10.3	0.42	+1.5*
Dressing percent (%)	46.2	0.33	45.7	0.36	+0.5
Easy carve leg (kg)	1.78	0.02	1.77	0.02	+0.01
Eye of short loin (g)	307	5.47	294	6.37	+13
French rack (g)	428	5.47	416	6.37	+12
Combined backstrap cuts (g)	735	8.93	710	10.38	+25
Total weight of cuts (kg)	2.52	0.03	2.48	0.03	+0.4

* Indicates a significant difference between groups ($P < 0.05$)

Slaughter data is presented in *ref 20a* and should be considered in conjunction with the discussion around it.

Final conclusions from the trial:

- There was no significant differences between the groups in lamb live weights or lamb growth rates at either site. This is consistent with the lack of difference in the sire EBVs for PWT between the groups.
- Lambs in the high muscle group at Broomehill had a 1.56 mm deeper eye muscle than lambs in the low group when scanned live by ultrasound at an average weight of 40.85 kg. This was even greater than the difference predicted by the LAMBPLAN of 1.056 mm, based on the difference in the PEMD EBVs between the sires of the two groups.
- The turnoff of lambs for slaughter from the high group appeared to be earlier than the turnoff of lambs from the low group. However, given the incomplete slaughter information it is difficult to be confident that this was the case.
- There were no significant differences between groups in liveweight at slaughter, as was expected given that lambs were drafted for slaughter based on liveweight.
- In the final consignment of lambs from Shackleton, lambs in the low group had a higher average carcase weight and dressing percentage than lambs in the high group. Differences were not seen in the other two consignments, the reverse of the expected result, in which more muscled lambs would be expected to have a higher dressing percentage than less muscled lambs.
- In the second consignment of lambs from Shackleton, the lambs in the high group were on average 1.5 mm fatter at the GR site than lambs in the low group, this is consistent with the direction but in excess of the amount predicted by LAMBPLAN of 0.39 mm, given the difference in PFAT EBVs for the two groups of sires.
- No significant differences between groups were seen in the retail meat yield of the easy carve leg, eye of short loin and French rack cuts when they were measured at one slaughter from each site.
- Lambs from the high muscle group tended to have slightly heavier loin and rack cuts than lambs from the low muscle group, while sire selection based on eye muscle depth tended to have a smaller influence on the retail weight of the leg cut.
- A significantly deeper eye muscle in lambs scanned live, did not appear to translate to a significantly higher retail meat yield, even in the loin and rack cuts which are comprised of eye muscle.

Number	21
Name	**Elmore - Ewe & Ram Evaluation PIRD**
Traits researched	Growth, WT
Date	1998-1999
Target audience	Ram buyers
Target	Meat, Maternal and Wool
Source	MLA PIRD
Contact	Kieran Ransom, M: 0419 320 824 E: kieran.ransom@bigpond.com

Further Information

Permission	Yes
Summary of resources	Final report to MLA
File and format	**21a** 97V01 Elmore pird.pdf

Key Findings

- High performance LAMBPLAN tested rams produce more meat from every lamb produced.
- Second cross lambs had on average an extra 1 kilogram of carcase weight and the average first cross lambs had on average an extra 0.55 kilograms of carcase weight.
- Estimated breeding values for growth are a very accurate way to select rams for use in commercial production of lambs.
- The commercial value of purchasing high performance rams for use with crossbred ewes was calculated to be $399, while that for Merino ewes was calculated to be $209 - over an estimated four years of the ram's working life.

Useful Information

- Lambing commenced 15 April 1998 and on 1 May 1999.
- In 1998, all lambs were sold in October and in 1999 lambs were sold in two drafts - in September and October.
- Rams were structurally similar with similar FAT and EMD EBVs.
- Lambs were weighed and fat scored throughout.
- The progeny were managed together and supplementary fed when needed
- Ewes were 2.5 years of age. 200 Merino ewes and 190 BLxMerino crossbred ewes were randomly divided into two groups, each to be joined to high growth LAMBPLAN EBV (+4kg) or average LAMBPLAN EBV (0kg) rams.
- Carcase price of $1.95/kg is used for calculations.

Background

The trial compared high performance LAMBPLAN tested Poll Dorset rams against average performance rams, as well as crossbred and Merino ewes as a source of prime lamb mothers.

The Elmore Field Days Committee and the Campaspe Prime Lamb Group wanted to address this comparison and also wanted to quantify the value of using performance tested terminal sires. The field days site has enabled the management of the different treatments to be run under identical conditions, and therefore the progeny of the crosses truly reflects the differences in genetics and mothering ability of the rams and ewes respectively.

Results

- High performance LAMBPLAN tested rams produce more meat from every lamb produced.
- Second cross lambs had on average an extra 1 kilogram of carcase weight as compared to the average first cross lambs had on average an extra 0.55 kilograms of carcase weight as compared to the average.
- Estimated breeding values for growth are a very accurate way to select rams for use in commercial production of lambs.
- The commercial value of purchasing high performance rams with Crossbred ewes was calculated to be worth $399, while the Merino ewes was calculated to be worth $209 over an estimated four years of the rams working life.

Table1: Differences in lambs produced from high and average performance LAMBPLAN tested rams*. Average of two years.

	Crossbred Ewes	**Merino Ewes**
High performance ram (kg/carcase)	22.38	21.02
Average performance ram (kg/carcase)	21.33	20.47
Difference between High and average rams (kg/carcase)	**+1.05**	**+0.55**
Profit from purchasing high performance rams (If high performance rams sired 50 lambs/year for 4 years at $1.90/kilogram carcase value)	If carcase value=$1.90/kg and ram sires 50 lambs/year and each lamb was 1.05 kgs heavier than the average **Profit = $99.75 / year** Over 4 years life of ram **= $ 399**	If carcase value=$1.90/kg and ram sires 50 lambs/year and each lamb was 0.55 kgs heavier than the average **Profit = $52.25** Over 4 years life of ram **= $ 209**

High performance rams produced heavier first cross and second cross lambs. High growth LAMBPLAN tested rams(+ 4 kg EBV for growth) produced on average 0.8 kilograms of additional carcase weight over the two years of the trial. Therefore, the trial successfully validated LAMBPLAN as an accurate measure of the ram's potential to produce heavier progeny.

Number	22
Name	**Information Nucleus Flock**
Traits researched	Growth, carcase, meat, wool, reproduction and disease traits
Date	2007 – ongoing
Target audience	Ram breeders
Target	Meat, Maternal and Wool
Source	Sheep CRC
Contact	Professor Julius van der Werf , Ph: 02 6773 2092 E: julius.vanderwerf@une.edu.au Information Nucleus Flock – Operations Dr Ken Geenty, Ph: 02 6773 1993 E: kgeenty@une.edu.au

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	Website Paper
File and format	**Background information on INF** http://www.sheepcrc.org.au/about/information-nucleus-overview.php **Latest updates on genetics/genomics and INF** http://www.sheepcrc.org.au/management/summary-of-progress-in-genomics-and-genetics.php **22a** Paper van der Werf J. H. J., Kinghorn B. P., Banks R. G. (2010) Design and role of an information nucleus in sheep breeding programs. *Animal Production Science* 50, 998–1003.

Key Findings

- The Information Nucleus Program (INF) will allow breeders to more rapidly improve genetic progress by providing increased industry linkage, producing information on new and hard to measure traits and generating genomic information.
- The INF is a large scale progeny test of key young industry sires measuring an extensive range of traits across differing environments and provides a resource to explore a range of research questions.

- The INF has used young sires with ASBV information extensively across their sites, this creates a database that can be used to highlight progeny performance compared to young sire genetic predictions. Section 23 shows that INF sire ASBVs for carcase attributes produce progeny with predictable performance and below we highlight that Merino ASBV information predicts progeny performance.

Useful Information

Original design:

- The original design involved 4250 ewes and their progeny bred from key young industry sires selected for high performance.
- Originally managed by 5 (850 ewes each) research parties (UNE, I&I NSW, DPI Vic, SARDI and DAFWA) with 3 operating as split sites. Sites were at Armidale (UNE), Cowra and Trangie (I&I NSW), Rutherglen and Hamilton (DPI Vic), Turretfield and Struan (SARDI) and Katanning (DAFWA)
- Matings represented the major sheep types in the industry and generated Merino (MxM), Maternal X Merino (MatxM) and Terminal first (TxM) and second cross progeny (TxMat).
- Breeds crossed with Merinos for maternal progeny included Border Leicester, Dohne, SAMM, Coopworth and Corriedale.
- Each year 100 young sires with Sheep Genetics information were selected and mated by AI using frozen semen across four sites.

2012 design:

- A new design commenced in 2012 whereby sites have been reduced to larger scale sites located at Katanning and Kirby.
- A total of 5,500 ewes are run across the sites with the ewe base made up of Merinos and BLxMerino, with joinings to Merino, White Suffolk and Poll Dorsets
- DNA technologies will play a bigger part in the new sites through DNA parentage and incorporation of genomic breeding values allowing more rapid genetic gain, particularly for hard or expensive to measure traits (e.g. meat quality).

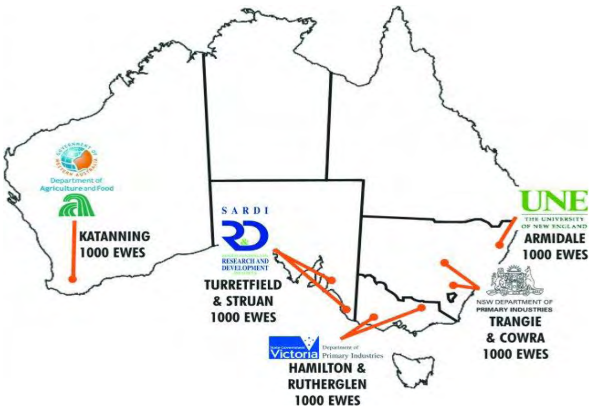
Background

The Information Nucleus (INF) Program integrates sophisticated genetic design and analysis with comprehensive measurement of biological and production parameters. It will allow breeders and commercial producers to quickly exploit information on breeding values for new traits potentially supported by information on animals' genomes to achieve more rapid genetic improvement in their flocks and across the whole sheep industry. The Information Nucleus also provides the base for core research activities in other CRC programs and enhance the application of results by industry.

The Information Nucleus tests progeny of key young industry sires for an extensive range of traits in differing environments. This information is added to the Sheep Genetics (SG) database to enhance the accuracy of Australian Sheep Breeding Values (ASBVs) used by industry. The Program also analyses and uses genotypic information on Information Nucleus progeny and industry sires to estimate and test SNP panels as predictors of breeding value. Genetic information is generated on new and novel traits and traits that are difficult or expensive to measure on-farm that may be related to wool and meat quality, disease resistance and reproductive fitness. The Information Nucleus will also be the focus of management, wool and meat research being undertaken in the other CRC research programs.

The original program involved a population of approximately 4250 ewes and their progeny bred from key young industry sires selected for high performance, likely to have industry impact and have genetic variation for a range of traits. The Information Nucleus was managed in several flocks across a range of Australian production environments, with a new sample of sires selected each year.

Location of original Information Nucleus Flocks in Australia.



Numbers of sires, ewes mated and progeny annually in the Information Nucleus

Sires	Ewes	Progeny	Retained	Slaughter
40 Merino (M)	1700 M	1445 M x M	723	570
20 Maternal (Mat)	850 M	723 BLxM	362	290
40 Terminal (T)	850 M	723 BLxM	-	570
850 Mat	723	TxMat	-	570
Total	4250	3613	1085	2000

The phenotypes of the progeny are evaluated for a large number of growth, carcase, meat, wool, reproduction and disease traits. The crossbred lambs are grown out and slaughtered in processing plants with industry partners.

Detailed information on carcase and meat traits, meat yield and samples for laboratory testing are collected. The MxM progeny are evaluated for a wide range of wool performance including new and novel traits with the wethers subsequently slaughtered for carcase and meat evaluation. The MxM and MatxM ewes are retained and mated naturally to evaluate reproduction and maternal traits. Blood and tissue samples are collected for genotyping and the molecular genetic studies.

Results

A vast amount of data, analyses and results have been produced as a result of the INF program and will continue to be produced throughout the life of the Sheep CRC (set to conclude 2014). The immediate results and benefits of the program to the sheep industries have been the delivery of ASBVs with enhanced genomic information. These breeding values are currently referred to as Research Breeding Values (RBVs).

RBVs for genomically analysed traits were developed in a pilot project and released to participating Merino (growth, carcase, eating quality, fleece, wrinkle) and Terminal (growth, carcase, eating quality) sire breeders. RBVs for maternal and composite breeds are expected to take longer to develop due to less data being available for these breed groups.

Genomically analysed traits are expected to include:

Trait Status	Terminals	Merinos
Existing as RBVs	PWT, EMD, PFAT	PWT, PEMD, PFAT, YFD, YCFW, YSL, EBWR
Anticipated in future	SF5, IMF, LMY, CWT, CEMD, CFAT, POLL, CALPASTATIN, PEDIGREE	SF5, IMF, LMY, CWT, CEMD, CFAT, BWT, POLL, PIGMENT, PEDIGREE

Where

PWT - Post weaning weight	CEMD - Carcase eye muscle depth
PFAT - Post weaning fat depth	IMF - Intra-muscular fat
PEMD - Post weaning eye muscle depth	CWT - Carcase weight
YFD - Yearling fibre diameter	CFAT - Carcase fat
YSL - Yearling staple length	BWT - Birth weight
YCFW - Yearling clean fleece weight	POLL - Polled horn
EBWR - Early breech wrinkle	PEDIGREE - Sire/Dam pedigree
SF5 - Shear force	PIGMENT - Pigmentation of hooves and skin
LMY - Lean meat yield	CALPASTATIN - Calpastatin gene present (tenderness)

The potential benefits of RBVs are:

- Early selection of young sires using traits which are difficult or expensive to measure;
- Increased rate of genetic gain i.e. faster improvement in targeted traits;
- Improved lamb nutritional and eating quality, increasing customer demand and improving value throughout the entire lamb industry;
- Reduced reliance on chemical intervention for parasites and improved welfare management.

The Sheep CRC website is regularly updated with latest results from this work (www.sheepcrc.org.au).

The INF flocks are also a basis for additional wool and meat research with the meat component discussed in section 23 of this document. Some results from the Merino performance is reported below:

Merino Results Generated to highlight the value of ASBVs

The following charts show results for Merino sires used in the INF for the 2010 drop across sites and have been generated to highlight the value of ASBV technologies. The charts compare the sire ASBVs for fleece and growth traits with their progeny yearling phenotypic performance analysed within the INF dataset and reported as flock breeding values (FBV) (source Sam Gill, Sheep Genetics, September 2012).

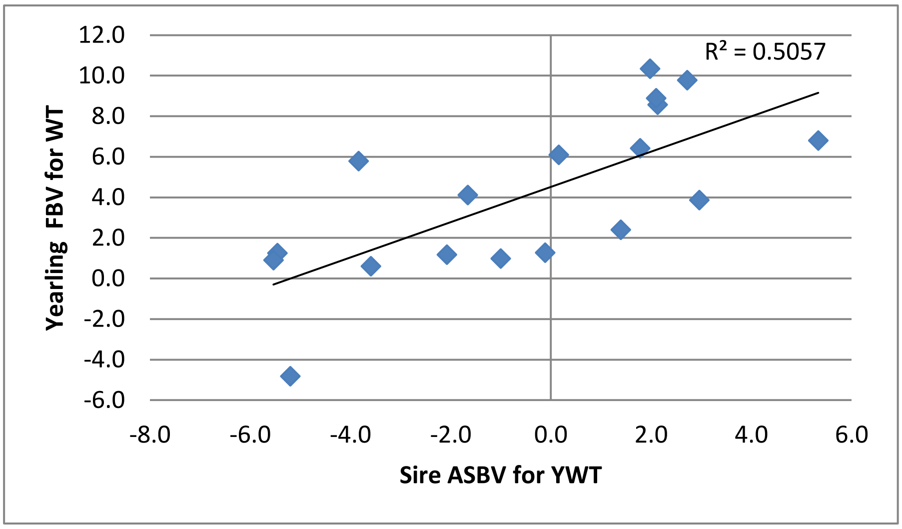


Chart 1: Yearling Weight Performance – 2010 Drop – Merino sires with Merino progeny

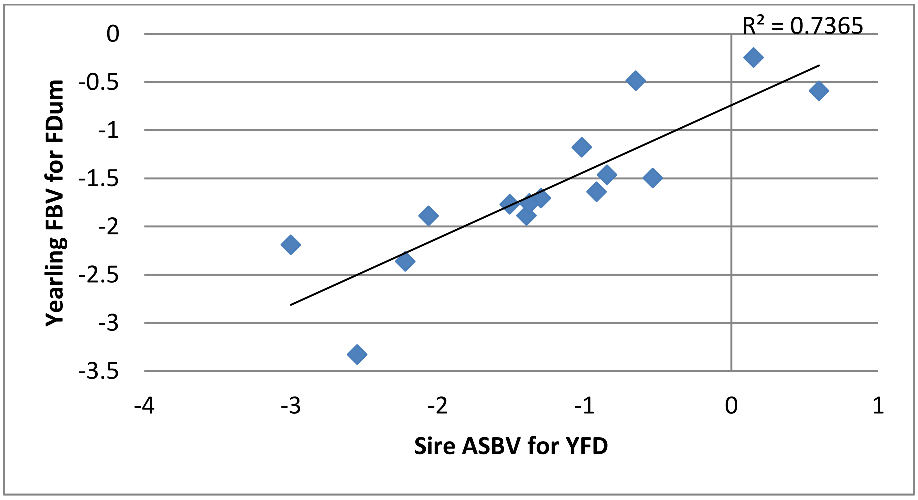


Chart 2: Yearling Fibre Diameter Performance – 2010 Drop – Merino sires with Merino progeny

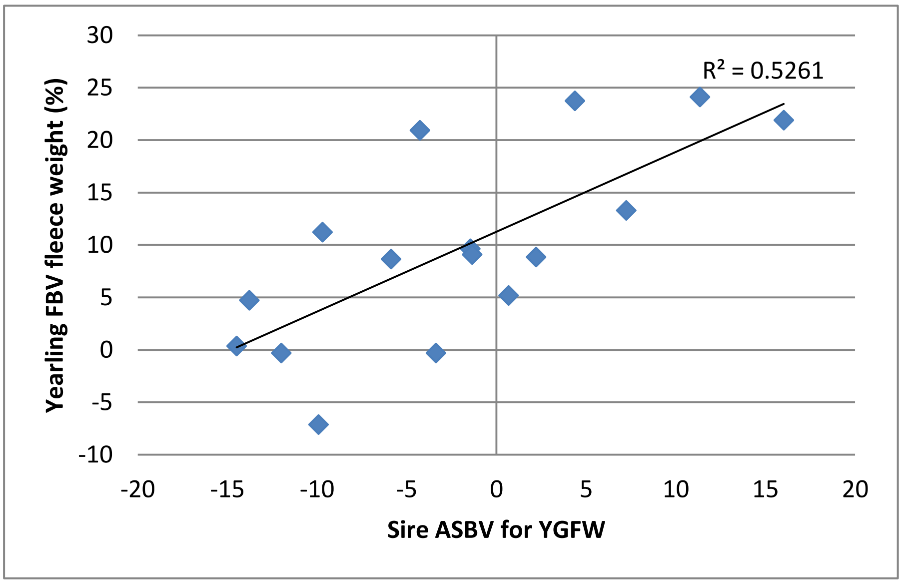


Chart 3: Yearling Greasy Fleece Weight Performance – 2010 Drop – Merino sires with Merino progeny

Number	23
Name	**Sheep CRC Meat Program**
Traits researched	Growth, carcase, meat, wool, reproduction and disease traits
Date	2007 – ongoing
Target audience	Ram breeders
Target	Meat, Maternal and Wool
Source	Sheep CRC
Contact	Professor Dave Pethick, Ph: 08 9360 2246 E: d.pethick@murdoch.edu.au

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	Papers Powerpoint presentations Practical Wisdom Sheep CRC Resources
File and format	**Background information on INF** http://www.sheepcrc.org.au/about/information-nucleus-overview.php **Latest updates on genetics/genomics and INF** http://www.sheepcrc.org.au/management/summary-of-progress-in-genomics-and-genetics.php **23a LAMBEX PPT** Lambex_Fiona Anderson2012.pdf **23b LAMBEX PAPER** lambex paper LMY.pdf **23c** Gardner G. E., Williams A., Siddell J., Ball A. J., Mortimer S., Jacob R. H., Pearce K. L., Hocking Edwards J. E., Rowe J. B., Pethick D. W. (2010) Using Australian Sheep Breeding Values to increase lean meat yield percentage. *Animal Production Science* **50**, 1098–1106. **23d** lean meat yield brochure 160712.pdf **23e** Selection_for_growth_and_lean_meat_yield.pdf

Key Findings

- Lean meat yield percentage can be manipulated using the ASBVs for growth, fat and muscling, with PWT increasing size, PEMD increasing muscling and PFAT decreasing fat.
- Carcase weights can be significantly increased by using sires that are genetically superior for weight.
- Use of high growth sires also has an impact on mature weights, carcase composition and the performance of lambs under high and low nutrition.
- Using sires selected concurrently for muscle and growth, will increase lean meat yield, reduce fat and improve feed conversion efficiency.

Useful information

- Research for the Sheep CRC's Meat Quality program is based on the Information Nucleus Flocks (INF) as described in section 22.
- Approx. 100 sires which are divergent for a range of traits are joined across each of the 8 INF sites.
- A subset of progeny are slaughtered at an average carcase weight of 21.5kg.
- Hot standard carcase weight (HSCW) and GR tissue depth are recorded along with a number of other carcase and meat quality traits.
- A further subset of carcases undergo CT scanning to allow division into 3 primal cuts.

Background

The Sheep CRC's Meat Quality program will develop and test in industry new technology to underpin the continuous improvement of high quality lamb and sheep meat for domestic and international consumers. The program aims to increase the retail meat yield per head while at the same time improving eating quality and the human nutritional value of the meat.

This program will deliver:

i. A range of new meat quality phenotypes to underpin genetic parameter estimation and permit estimation of molecular breeding values (Project 3.1);
ii. An understanding of the biology of the phenotypes that contribute to desired industry outcomes such as increased lean meat yield, improved eating and meat quality (Project 3.2);
iii. Delivery of lean meat yield measures and an increased rate of lean meat yield adoption (Project 3.3); and
iv. Delivery of technologies for improving processing efficiency and quality (Project 3.4).

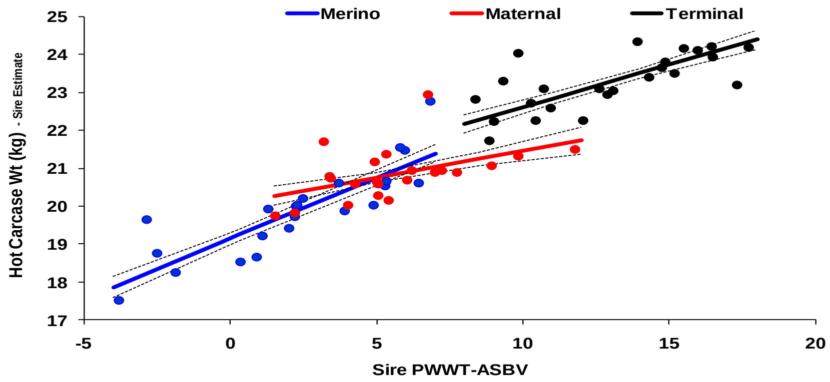
Results

Results from the meat program will be available via the Sheep CRC website and through a network of producer demonstration sites (***ref 23d***). The selected results presented here have been chosen to emphasise that existing industry ASBVs work.

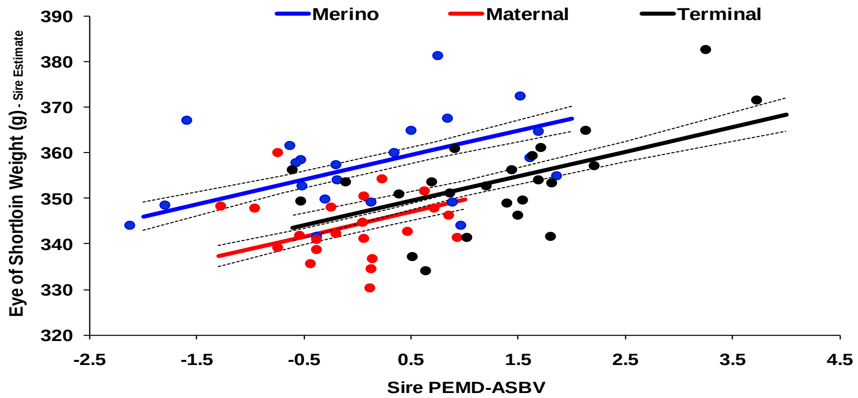
The Sheep CRC has also produced some useful resources located on their websites titled "Practical Wisdom". Two of these resources relating to the use of ASBVs and implications for growth, muscle and leanness.

Ref 23b

Whilst conducting research into increasing the percentage of lean meat yield, the meat program of the Sheep CRC have developed information to show that selection using PWT, PFAT and PEMD results in improvements in lean meat yield.



Lambs with high PWT values are faster growing and reach heavier slaughter weights or target weights sooner. Terminal sire lamb offspring had an increased pre-slaughter live weight and HSCW of 3kg and 2.22 kg over 10 PWT ASBV range (***ref 23c***).



Ref 23c

Progeny of high PEMD terminal sires have increased weight of the loin and eye muscle area which is similar to that found by previous research.

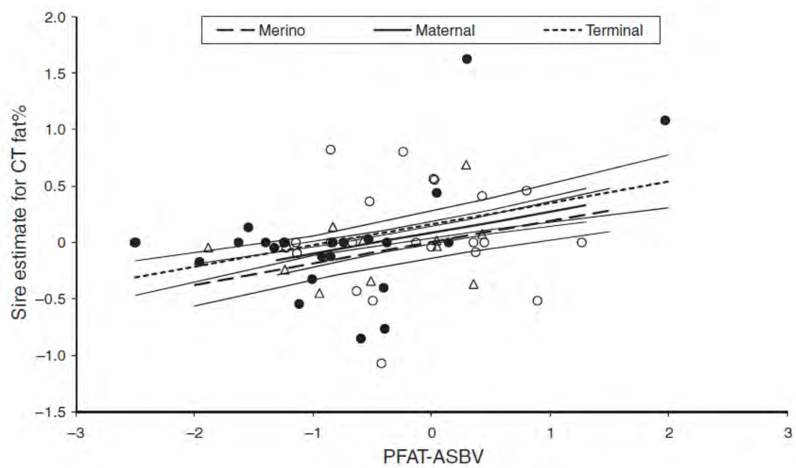


Fig. 4. Relationships between sire estimates for CT fat% and post-weaning fat depth (PFAT) Australian Sheep Breeding Values (ASBV) for Merino, maternal and terminal sires. Sire estimates are represented as (△) for Merino, (○) maternal and (●) terminal sires.

Offsetting the increased muscle in the loin was C-site fat depth, which decreased (P< 0.05) by 0.5mm (14%) across the 4.4-mm range in terminal sire PEMD ASBV.

The Sheep CRC has a number of "Practical Widsom" papers on their website that capture some of the outcomes and general principles for selection for growth, muscle and leanness.

***Ref 23e* – Written by Dr David Hopkins, NSW DPI, David.Hopkins@dpi.nsw.gov.au**

What are the implications for selecting for high growth?

Sires that are superior for growth may not necessarily increase birth weights and associated lambing difficulties. Although there is generally a good correlation between weights at different ages, some of the potential gain from selecting for heavier weights may not be realised until animals are older; while lambs are still on their mother, her influence, particularly her ability to feed the lamb, can mask the lamb's own potential. After weaning, the maternal effect declines.

Figure 2 shows the extra liveweight gained from using sires with higher ASBVs for yearling weight when the progeny were killed at different ages. In this experiment, the animals were killed at 4 months (sucker lambs), 8 months (carry-over lambs), 14 months (yearlings) and at 22 months. Using sires with a YWT ASBV of +10 kg produced no extra weight when lambs were slaughtered as suckers, an extra 1.4 kg liveweight when killed at 8 months, an extra 3.4 kg at 14 months and an extra 6.4 kg when killed at nearly two years of age. Similarly, when sires selected for high PWT ASBVs were used, the full growth potential was not realised until the progeny weighed 30 kg or more.

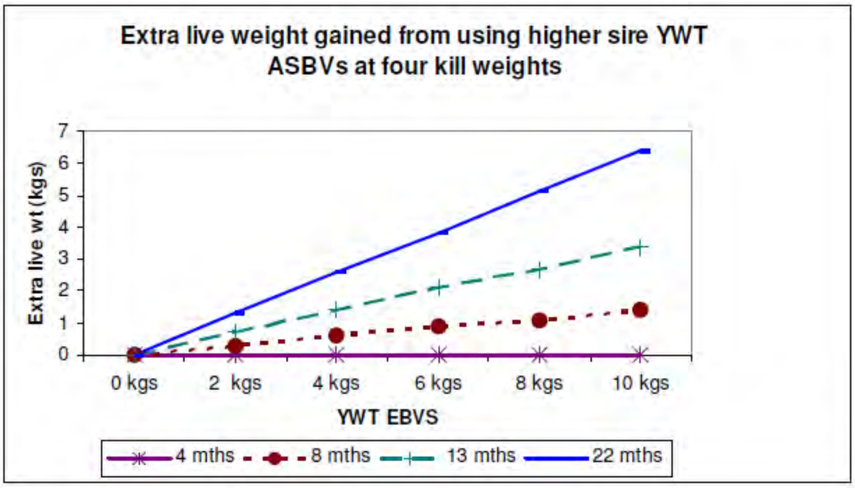


Figure 2. Extra liveweight produced from lambs bred from sires with high YWT ASBVs, when killed at 4 ages from 4 to 22 months.

What are the effects of feed restriction?

In years of poor pasture growth or early season cut-off, lambs grow slowly if not supplemented, therefore, the implications of poor nutrition on the ability of lambs to recover and the characteristics of the carcase were examined. Figure 4 shows the increase in daily growth rate of lambs as the sire ASBV for PWT increased under high and low nutrition. In this study, where restricted lambs were growing at 55 to 75g/head/day, the use of sires with higher ASBVs for growth provided a similar growth rate advantage to those on good nutrition. In other words, the advantage of using a sire that has an ASBV of +14 for PWT rather than +3 was 20 grams per head per day, whether fed fully or not. However under low nutrition, progeny growth may only be 60–65% of the full potential under good nutrition. When restricted lambs were re-fed, they grew faster (compensatory growth) than the well fed lambs with a similar response to sire ASBV.

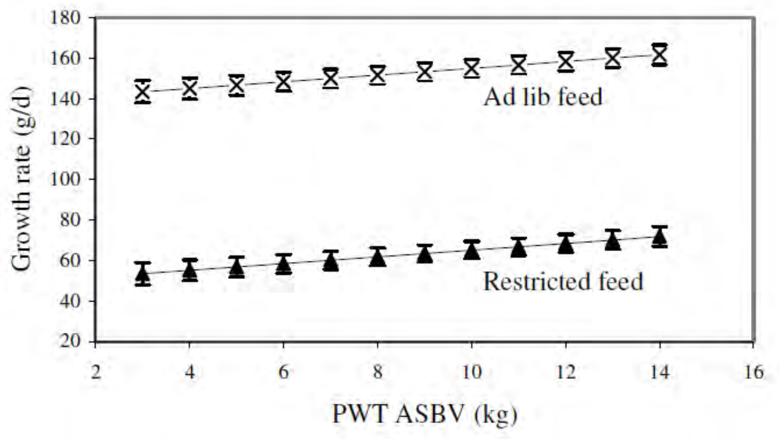


Figure 4. Extra liveweight produced from lambs bred from sires with high PWT ASBVs on either ad lib or restricted feed.

How is carcase composition affected by sire selection?

Increasing growth rates through breeding will produce lambs that reach target weights more quickly, but when there is no selection emphasis on fat or muscle, will produce lambs that have more fat and not necessarily higher lean meat yield.

Lambs that have been weaned early or had restricted feed post-weaning can be fed to catch up, so producing carcases with minor differences in composition compared to lambs fully fed. Whilst total carcase fat may not differ between lambs that have compensated and those on good feed, fat deposition over the carcase may differ, with more fat deposited over the GR site in the lambs that were restricted. As this is the site used to assess lambs for fat, this may lead to lambs that have had restricted feeding being assessed as fatter. In the project reported above, this effect was small, with only an extra 0.8 mm fat over the GR site for a 21 kg carcase.

Lean meat yield can be increased by selecting for increased growth and reduced fat. For example, two carcases from a trial that had similar carcase weight (23.6 and 23 kg), but different fat scores (2 and 4 respectively), had considerable differences in GR fat and saleable meat yield. The score 2 lamb had 10 mm fat at the GR site and 56% saleable meat, whereas the fat score 4 animal had 20 mm fat and 48% saleable meat; the leaner animal produced 2 kg more lean meat than the fat animal.

How is muscle affected by selection?

There can still be large variation in the amount of meat produced within a fat score, primarily due to muscling. Selection for increased muscling, as eye muscle depth (EMD) will increase meat yield by reducing bone and fat content. The graph below shows results for levels of fat in carcases from sires with no trait selection (Control), compared with high growth ASBVs (Growth) and high muscle ASBVs (Muscle) and under both low and high nutritional conditions. The interesting result is that under high nutrition, it is usual for animals to grow more but also to lay down more fat — except when selected for muscling.

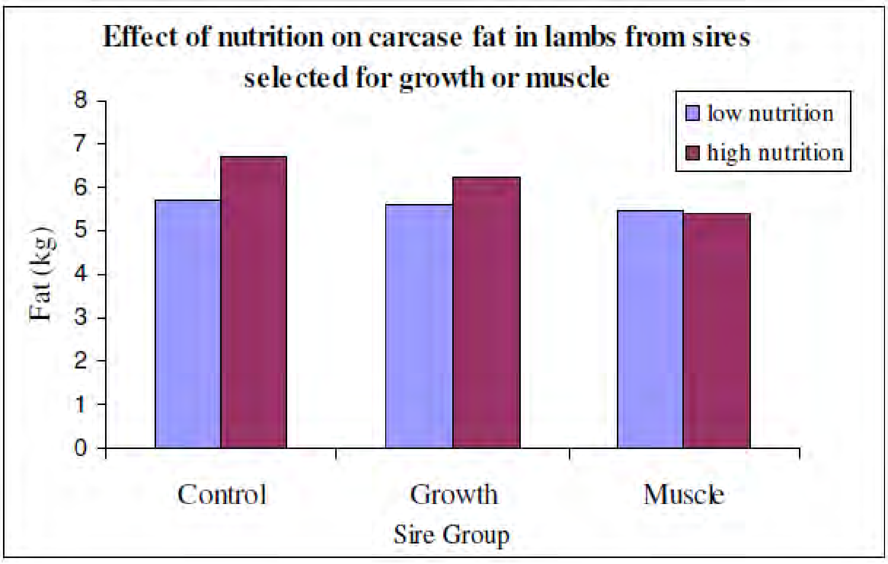


Figure 5. Comparison of carcase fat levels in lambs from sires selected for growth or muscling compared with unselected (control) sires under different levels of nutrition.

Animals selected for muscling grow more muscle, as expected, but sometimes at the expense of other traits like fat, bone and wool. Under low nutrition, they are programmed to grow muscle at the expense of wool and bone, and under high nutrition at the expense of fat. Selection for muscle can therefore be a powerful tool in reducing levels of fat. In this research the use of sires with low fat ASBVs reduced fat by 4% whatever the level of nutrition. Using sires with high muscle ASBVs, reduced fat by 3% under low nutrition and by 10% under high nutrition. However, to ensure that meat is not tough, this research shows that very high muscle breeding values can be selected as long as growth ASBVs are greater than +5 kg.

How are lean meat yield and feed conversion efficiency affected by selection?

Lean meat yield is the proportion of meat produced from a carcase, excluding fat and bone. Higher lean meat yield means more valuable product, as consumers prefer meat not bone and fat. Increased selection for muscling will reduce bone, increase muscle (with a localized effect on the loin) and also reduce fat, as described previously. The reward for increasing muscle is not captured under a normal grid price scheme based on carcase weight and GR. The reward for reduced fat from muscle selection will also not be rewarded under this system, as the GR measure is not sensitive enough to detect these differences in fat levels (See Quality Sheepmeat – Carcase characteristics of the major sheep breeds in Australia).

However, while lean meat yield is not commonly measured or paid for, there are good reasons to select for increased lean meat yields:

- Use of high growth and muscle animals has the potential to reduce feed costs, as these animals will reach targets more quickly and eat less feed to get there. For a pasture-based system, this can mean as much as four weeks less grazing and for feedlots, up to two units of feed conversion. This is based on the increased efficiency of laying down muscle instead of fat.
- Improvements in lean meat yield will become increasingly important as processors and retailers are able to easily measure it. As lamb supply increases, there will more discrimination for fat and a value put on higher value cuts.

What are the implications of selection for growth and muscle?

When sires with high YWT ASBVs are used in a self replacing flock, the ewe progeny retained for breeding may have bigger mature weights than expected, which will impact negatively on feed requirements and stocking rates.

A balanced selection for muscling, fat and growth will improve lean meat yield with additive benefits to meat quality and feed conversion efficiency. The effect of a sire’s genetics on carcase composition is greater than nutrition and can help offset some nutritional limitations. However, good growth rates close to slaughter are still required to achieve good meat quality. This means that for lamb finishers, knowledge of the genetic background of lambs is far more important than knowledge of their nutritional background.

Selection only for growth will produce animals that reach weights faster, but will have more fat and larger mature weights, this includes bigger retained ewes, but not necessarily heavier birth weights when they are lambs.

Progeny of sires with higher growth exhibit faster growth under both good and poor nutrition. However, only 60–65% of potential growth is achieved under very low nutrition. But lambs that have been restricted and re-fed, end up having only minor differences in carcase composition.

Selection for muscling will increase lean meat yield by reducing fat and bone, relative to meat. It can be pushed without effecting meat quality (toughness) providing growth ASBVs are at least +5 kg.

Take home messages

- When choosing sires, select for a combination of high growth and muscling (rather than just one or the other being high) and also select for lower fat.
- Lambs that have suffered poor nutrition through the growing period can be successfully fed to catch up weight and still have suitable carcase characteristics (however, check the economics before doing so).
- Regardless of the genetics, ensure all lambs are achieving high growth rates prior to slaughter to ensure good meat quality.
- It is more important for lamb finishers to source lambs with superior genetics for growth than lambs that have been on good feed.

Further reading

Hopkins, D.L., Stanley, D.F., Martin, L.C. and Gilmour, A.R. (2007). Genotype and age effects on sheep meat production. 1. Production and growth. *Australian Journal of Experimental Agriculture* **47,** 1119-1127.

Hopkins, D.L., Stanley, D.F., Martin, L.C., Toohey, E.S. and Gilmour, A.R. (2007). Genotype and age effects on sheep meat production. 3. Meat quality. *Australian Journal of Experimental Agriculture* **47,** 1155-1164.

Hopkins, D.L., Stanley, D.F., Toohey, E.S., Gardner, G.E., Pethick, D.W. and van de Ven, R. (2007). Sire and growth path effects on sheep meat production. 2. Meat and eating quality. *Australian Journal of Experimental Agriculture* **47,** 1219-1228.

Hopkins, D.L., Stanley, D.F., Martin, L.C., Ponnampalam, E.N. and van de Ven, R. (2007). Sire and growth path effects on sheep meat production. 1. Growth and carcass characteristics. *Australian Journal of Experimental Agriculture* **47,** 1208-1218.

Hopkins, D.L., Hegarty, R.S. and Farrell, T.C. (2005). Relationship between sire estimated breeding values and the meat and eating quality of meat from their progeny grown on two planes of nutrition. *Australian Journal of Experimental Agriculture* **45***,* 525-533.

Siddell, J. McLeod, B.M., Toohey, E.S., van de Ven, R. and Hopkins, D.L. (2012). Impact of sire breeding values for muscling on loin muscle. *Proceedings of the 29th Biennial Conference of the Australian Society of Animal Production (in press).*

Hopkins, D., Stanley, D., Martin, L., Gilmour, A. and van de Ven, R. (2006). Influence of sire growth estimated breeding value (EBV) on progeny growth. *Proceedings of the 2006 Agribusiness sheep updates,* pp. 23-25.

Stanley, D.F. Hopkins, D.L. Martin, L.C. and van de Ven, R. (2006). Influence of sire growth EBV on early lamb growth. *Australian Society of Animal Production 26th Biennial Conference,* (Short communication No. 87).

Number	24
Name	**Genetic Trends in the Australian Sheep Industries**
Traits researched	Index
Date	2009
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	AGBU
Contact	Andrew Swan P: 02 6773 3209 E: andrew.swan@une.edu.au

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	AAABG paper and presentation
File and format	**24a** *AAABG Paper* Swan, A.A., Brown, D.J., and Banks, R.G. (2008) *Proc. Assoc. Advmt. Anim. Breed. Genet.* **18**:326. swan_aaabg_2009.pdf **24b** *Presentation* swan192-p1.pdf

Key Findings

- Rates of progress have increased significantly since 2000 for the Terminal Sire, Border Leicester and Coopworth groups.
- Merinos have maintained a relatively constant and favourable rate of progress over the whole time period.
- Compared to simple breeding programs simulated for each breed group, Terminal Sires are exceeding the simulated potential rate of gain, Border Leicesters and Coopworths are approaching the potential gain, while Merinos are achieving only one third of the potential gain.

Useful Information

- Changes in profitability were estimated by increases in index values based on the most relevant index for the group.
- Genetic trends were estimated using results from the December 2008 LAMBPLAN and MERINOSELECT evaluations.
- Trends were expressed both as dollars per ewe per year ($ per ewe), and scaled by the standard deviation of the breeding objective.
- A program called SelAction was used to predict selection responses.

Background

Genetic progress is a key profit driver for the Australian sheep industry, and as a consequence there has been significant industry investment in performance recording and genetic evaluation systems since the late 1980s. The meat and dual-purpose maternal breeds have had access to Estimated Breeding Values (EBVs) through the LAMPLAN system since 1989, with across-flock evaluations becoming available in the mid 1990s. In the wool sector, across-flock evaluation began in the early 1990s through the Central Test Sire Evaluation program. Larger evaluations using on-farm data began in the late 1990s with the advent of Merino Benchmark and Merino Genetic Services. These systems, including LAMBPLAN, were merged under the banner of Sheep Genetics in 2005 (Brown et al. 2007). In this paper, we compare the genetic progress in predicted profitability since 1990 in the main breed groups serviced by Sheep Genetics.

Results

Estimated genetic trends are shown in Figure 1. Between 1990 and 2005, the Terminal Sire and Coopworth breeds have improved by around $17 per ewe, while Border Leicesters and Merino have improved by approximately $10 per ewe. However, when expressed in terms of the standard deviation of the objective, the Terminal Sires were well ahead of the other breeds, showing an improvement of almost 3 standard deviations. Coopworths have improved by 1.3 standard deviations, and Border Leicesters and Merinos by 0.7 to 0.8 standard deviations. The rate of progress shows an increase from 2000 in the Terminal Sire breeds, Coopworths and Border Leicesters, while the Merinos show relatively constant improvement over the entire period.

Predicted annual responses from SelAction and realised annual responses post 2000 are shown in Table 3. Under the within-flock breeding programs modelled, predicted annual responses ranged from 1.8 to 2.4 dollars per ewe, or 0.14 to 0.30 objective standard deviations. Compared to these figures, the realised response in industry ranged from 30% of the predicted response for Merinos to 111% for Terminal Sire breeds. The Border Leicesters and Coopworths were intermediate, achieving approximately 80% of the potential response.

Table 3. Predicted and post 2000 realised annual response in industry

Breed group	Annual response ($ per ewe)			Annual response (SD objective)		
	Predicted	Realised	Ratio (%)	Predicted	Realised	Ratio (%)
Border Leicester	2.0	1.7	85	0.14	0.11	79
Coopworth	2.4	1.8	75	0.17	0.13	76
Merino	2.3	0.7	30	0.15	0.05	33
Terminal Sire	1.8	2.0	111	0.30	0.33	110

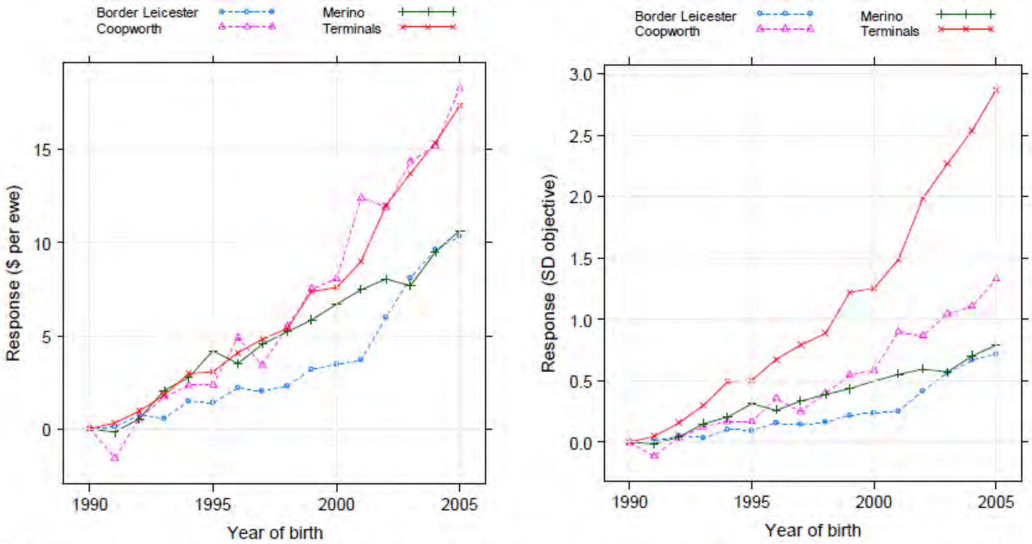


Figure 1. Genetic progress in the main Sheep Genetics breed groups between 1990 and 2005. The left panel expresses response in dollars per ewe per year, while the right has been scaled by the standard deviation of the respective breeding objectives for each breed.

Number	25
Name	**Sheep Productivity Trials/Ewe Competitions/Linked Trials**
Traits researched	Fleece traits, growth, reproduction
Date	Ongoing
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	DAFWA
Contact	Johan Greeff, DAFWA, Ph: 08 9368 3624 E: jgreeff@agric.wa.gov.auJohan

Further Information

Permission	Yes
Summary of resources	Overview bulletin from DAFWA Ewe trial guidelines Example report from a Ewe Trial
File and format	**25a** bulletin_sheepgenetics.pdf **25b** ewe productivity guidelines.pdf **25c** 04ME06_Report_Final_EXTERNAL.pdf

Key Findings

- Western Australia conduct wether and ewe trials to allow flock performance benchmarking.
- Wether trials follow similar protocols to those described in section 33 of this document.
- Ewe trials are an expansion of wether trials by allowing differences in reproductive performance to be observed.

Note

- Ewe trials, wether trials and sheep productivity trials emphasise a large variation in the genetic performance between animals. Superior performance in these trials is at times attributed to the incorporation of advanced genetic technologies like breeding values and indexes or the inclusion of objective measurement in selection programs. They also stress the need to use tools that describe genetic differences when making ram and sire choices.

Useful Information

- Ewe trials typically involved a random draft 50 ewes from each team – and were assessed for 3 years.
- Measurement of growth performance usually takes place for the first year of the trial.
- Ewes are joined in their second year to Merino rams and in the third year to terminal sires.

Background

Sheep productivity trials are the generic term for wether trials and ewe trials. These genetic tools are available to commercial growers as well as ram breeders. All trials have specific formats that allow one to benchmark flock performance. Wether trials have been running in Western Australia for nearly a decade and provide information on fleece traits and live weight. Ewe trials are more recent and provide additional information on reproduction and lamb growth.

Wether trials have made an important contribution in raising the awareness of the differences in performance which exist between ram sources but they provide information on wool production traits only. This has led to some criticism because lambs and surplus animals contribute to income. Using ewes instead of wethers and adjusting the trial design can accommodate these criticisms.

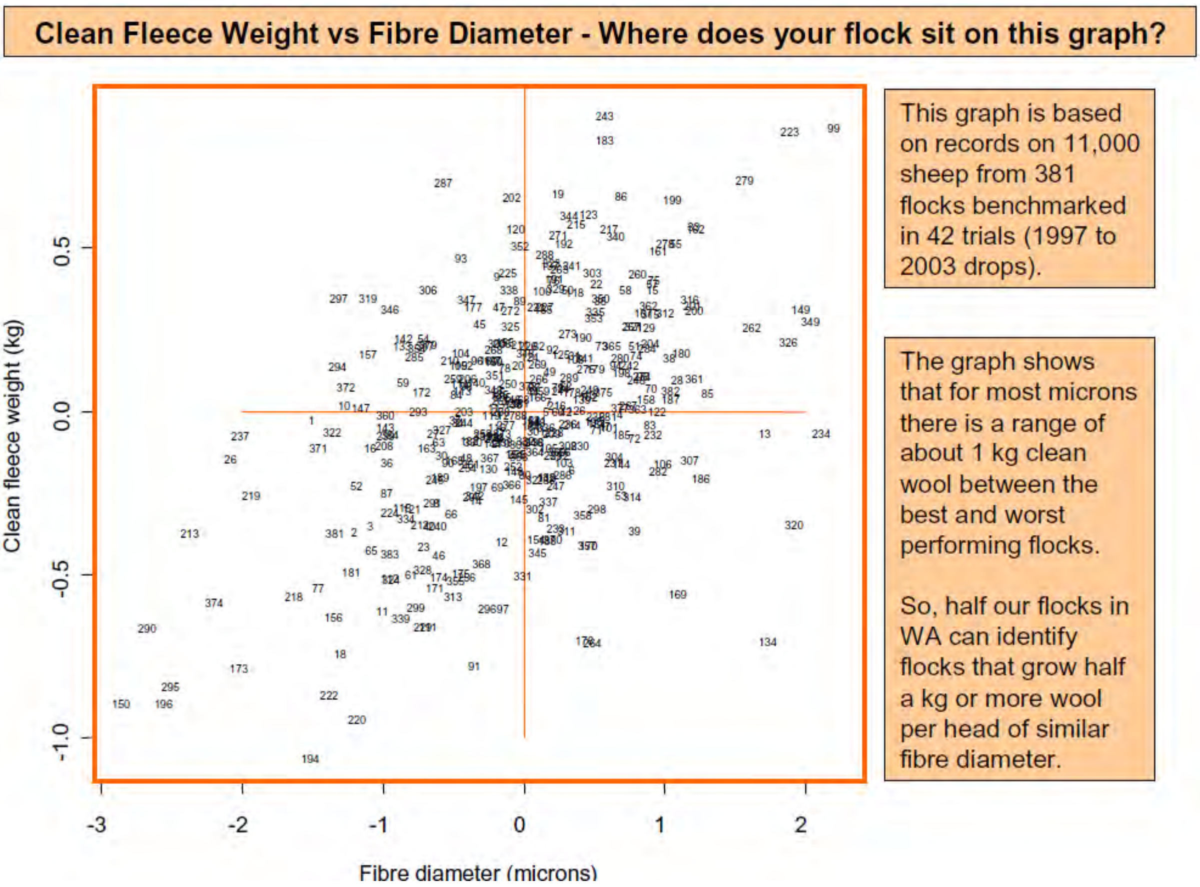
A link team, selected at random, is entered in all trials commencing with a particular drop. The performance of the link team across environments allows combination all of the data from all trials, starting with a given drop.

Teams have the opportunity to be assessed for fleece, growth, carcase and fertility traits.

Results

Ref 25a

Research and sheep productivity trial results demonstrate a huge variability in genetic productivity between flocks. For example a range of up to 2 kg clean fleece weight, 5 microns, 55 percentage points in lambing percentage and 20 kg live weight, can lead to big differences in gross margin between flocks. There is an opportunity for genetic improvement, depending on the producer's current ram source or the sire's performance. For example, Western Australian (WA) Wether Trial results suggest half the WA flocks could improve clean fleece weight per head by half a kilogram or more. The trial results suggest that this could occur while maintaining fibre diameter, by identifying genetically superior ram sources. A survey of past participants of wether trials indicated that 90% had learnt something about their flock. Of the 45% who considered they had made a significant change, about half had changed their ram source.



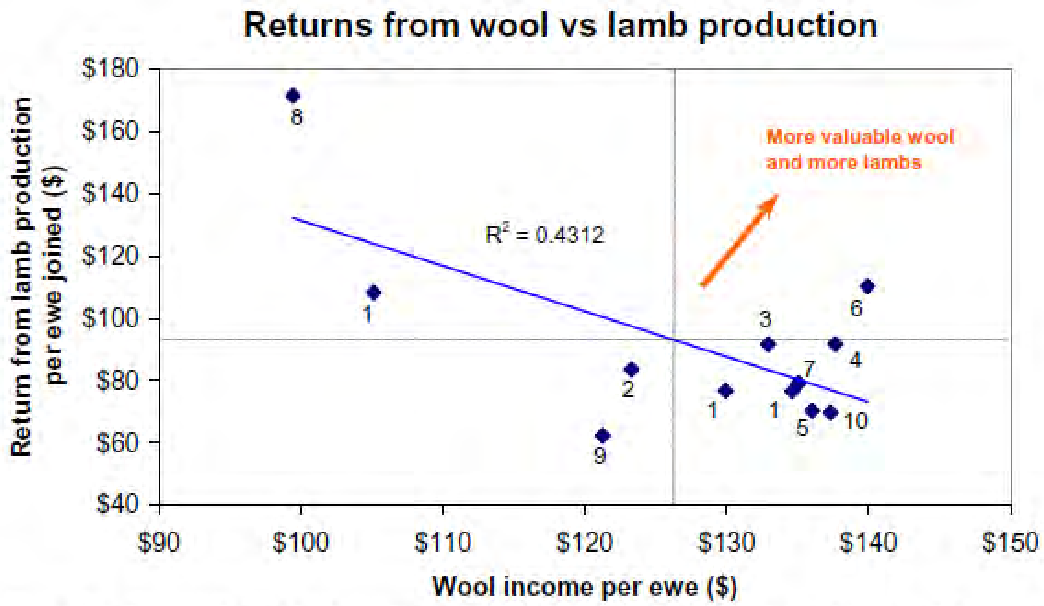


Figure 2. **The relationship between the return from lamb production per ewe joined and the wool income per ewe.**

Example Ewe Productivity Trial Results

Ref 25c – Merredin Ewe Trial – Breed Comparison

Disclaimer - The names of the different strains in this study are referred to by their breed name. However, their performance in this study only relates to the strains used in this trial and cannot be extrapolated to all members of each breed. Four strains of sheep were involved in the ewe productivity trial at Merredin, from the Merino, Dorper, Damara and Wiltshire breeds. It is well known that pre-test environmental conditions can impact on a team's subsequent performance in a trial. As the Wiltshire team was clearly below the expected weight for animal at entry age, it was decided to exclude their results, because it appears that this team may not have been a representative sample of the Wiltshire breed in Western Australia.

Merredin Ewe Trial - Key Findings

- The most profitable sheep system, in this trial, was Merino ewes mated to a terminal sire
- Dorper and Damara ewes are capable of weaning 70 – 80% lambs when they are mated as nine month old lambs
- High and consistent reproduction rates in these alternative strains are necessary to match profitability with a dominant wool flock producing both wool and lambs
- In the management of pure adult Damara ewes, further investigation is required to retain leanness to aid in successful conception as the fat tail can become a physical barrier to mating
- The selection of ewes with high reproduction traits, such as number of lambs born and number of lambs weaned will result in increased productivity and profitability
- The monitoring of worm egg counts throughout the trial demonstrated that the need to drench was minimal when combined with good pasture management and good sheep nutrition

Merredin Methodology

At the start of the trial, 42 Dorper, 48 Damara and 46 Merino ewe lambs of approximately the same age were brought to Merredin. The Dorper and Damara ewe mobs were randomly selected from five and three (respectively) different properties because, in 2004, no one farm could provide for the trial sufficient pure bred animals. The Merino ewe lambs were also drafted off randomly from the research flock on the Badgingarra research station of DAFWA soon after weaning. The Merino team was included in the ewe trial to link trial sites as genetically related ewes were included in other ewe trials throughout WA.

Once aggregated into one group, the animals were continuously run as a single mob for the duration of the trial, except at lambing. They were managed according to DAFWA recommendations, including Lifetime Wool, for best practice management of Merino sheep.

Each year, the ewe mob was mated to one sire breed for six weeks at a ram rate of between 1.5 and 3% during the months of February and March. The only exception to this was that a ram rate of 10% was used for the Damara ewe mob in year three of the trial. This was due to the limited ability by rams in 2006 to successfully mate the Damara ewes in a mixed mob due to their excessively large tails impeding joining.

Each year, approximately forty days after the rams were removed; the ewes were pregnancy scanned to determine the conception rates of the ewe groups. Just prior to lambing, the ewes were separated into their breed groups so that at marking, the lambs could be tagged and identified to their breed. Following marking, all ewes and lambs were pooled into one management group until the lambs were weaned four weeks later.

Live weight and body condition score measurements of the ewes were recorded regularly for the general management and observation of each ewe group.

In addition, for the Merinos, wool measurements were collected at each shearing commencing with the hogget shearing, and repeated at the first and second adult shearings. Mid side wool samples were analysed by a wooltesting laboratory for fibre diameter and yield, plus staple length and strength. Greasy fleece weight, style, colour and tenderness were also recorded to determine fleece value. Measurements of lambs included the number of lambs born, the number of lambs marked, the number of lambs weaned and the number present for marketing. Live weight and body condition scores of lambs were recorded at weaning and every four to six weeks until market weights were reached. These measurements were used to determine the growth rates of the lambs.

Other measurements included (Merino) easy-care traits such as dags, wool wrinkle and flystrike, as well as worm counts and lamb quality traits for all breeds. All management practices were recorded.

Merredin - Results

The objective of this trial was to benchmark the performance of strains from different breeds in a ewe productivity trial run in the eastern wheatbelt in order to compare their performance with that of other ewe flocks in WA. A ewe productivity trial removes the likely management and environment differences between sheep flocks by running them together so only the genetic performance is measured. However it is recognised that pre-test environmental conditions can affect the outcome of such trials. **In this trial, the implementation of a system that favoured one breed (Merino) is the likely reason for the relatively poorer performance of the other breeds.**

Attributes peculiar to the fleece-shedding breeds were not fully investigated, for example, different feed preferences and possibly feed conversion efficiency, low input management or accelerated mating systems, and there was no comparison of different management systems. Therefore, further economic modelling was performed using performance information from the different breeds obtained in the trial as an indication of industry 'best bet' management systems for each breed with realistic reproduction figures from producer experience (Kilminster, 2009 unpublished).

IT IS HIGHLY RECOMMENDED THAT REF 25C IS READ PRIOR TO THE USE OF THE FOLLOWING RESULTS:

Lambs in year 3 were sold at a price of $36.94 per head to a commercial abattoir. The market price for wool in year 1 was 666c/kg, year 2 1055c/kg and year 3 1075c/kg.

Table 6: Gross margins for Dorper, Damara and Merino ewes under the three-year trial farming system.

	Dorper	Damara	Merino
Total per ewe	$76	$32	$100
Total per hectare	$239	$131	$347
GM/ha/yr	**$90**	**$49**	**$130**

Weaning rates (%)

	Dorper	Damara	Merino
Yr 1	81	71	13
Yr 2	122	52	117
Yr 3	105	64	134

Lamb and wool prices received for each breed were as per the trial results:

Product values

		Dorper	Damara	Merino
Lamb value ($/hd):	Yr 1	46	46	46
(average per year)	Yr 2	52	51	49
	Yr 3	37	37	37
Wool value ($/kg clean):	Yr 1	-	-	6.66
	Yr 2	-	-	10.28
	Yr 3	-	-	10.75

Table 3: The reproductive performance and economic value (lamb) of Dorper, Damara and Merino ewes in year 3 (2007).

	Dorper	Damara	Merino
Ewe number	37	45	44
Joining age (months)	33	33	32
Joining live weight (kg)	77.1	71.6	70.2
Joining condition score (CS)	2.8	2.8	2.5
Day 90 CS	3.1	2.8	2.6
Pre-lambing CS	2.7	2.7	2.3
Lamb potential	59 (159%)	36 (80%)	64 (145%)
Lambs weaned	39 (105%)	29 (64%)	59 (134%)
Lambs weaned of lambs scanned	39/59 (66%)	29/36 (81%)	59/64 (92%)
GR of lambs from birth to market (assumes BW=5kg) g/h/d	222	189	209
kg lamb weaned per ewe mated	34.4	16.0	38.1
$ per ewe joined	$37.94	$23.81	$49.53

Note

(i) Lamb potential as recorded at scanning and includes dries, singles and twins as a proportion of ewes joined

(ii) All lambs were marketed for slaughter at six months of age therefore there was a large variation in the range of growth rates and therefore finishing weights for these lambs, the average of each group is reported in this table

Table 5: Wool trait averages and the economic value (wool) for Merino ewes in each year of the trial.

	Year 1 - 2005	Year 2 - 2006	Year 3 - 2007
Number of ewes	46	44	42
Age at shearing (months)	18	30	42
Greasy fleece weight (kg)	5.4	5.4	5.6
Clean fleece weight (kg)	3.7	3.9	3.6
Fibre diameter (µm)	20.3	20.3	19.5
CV (%)	19.0	18.6	18.1
Yield (%)	67.6	71.6	63.6
Staple Length (mm)	92.3	96.7	86.1
Staple Strength (N/ktx)	28.2	31.0	18.6
$ per ewe joined	$25.26	$40.79	$38.23

Note

(i) Merino ewes had 12 months wool at first shearing as they were shorn as lambs on entry to the trial

Number	26
Name	**Elders Next Progeny Trial**
Traits researched	FEC, FD, CFW, Live weights, FAT, EMD (live), estimated carcase value
Date	2001 - 2004
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	MLA, Elders
Contact	Richard Apps, MLA, Ph: 02 6773 3773 E: rapps@mla.com.au Greg Popplewell M: 0447 121 305 E: greg@popplewellc.om.au
What's missing	Fleece data correlated with EBVs

Further Information

Permission	Yes
Summary of resources	Brochure Power point slides
File and format	**26a** *Brochure* trial brochure.pdf **26b** *Power Point Presentation* Elders Next Results Aug04.ppt

Key Findings

- A progeny test trial involving both Merinos and terminal sires showed that EBVs did a good job at predicting the differences in progeny performance.
- EBVs are a good tool to help select the right genetics.

Useful Information

- 600 fine wool Merino ewes randomly mated by AI to Merino rams from Merino Validation Project (13 Merinos).
- 600 fine wool Merino ewes randomly mated by AI to Terminal LAMBPLAN evaluated rams (6 Poll Dorsets and 3 White Suffolks).
- Extensive progeny measurement was carried out.
- The project was established prior to the launch of Sheep Genetics in 2005 and helped establish Merino linkages for the Merino Validation Project.
- Test terminal rams were selected as ram lambs, to encourage industry to reduce generation interval.
- Calculations assumed $4.00/kg carcase value.

- One site established near Goulburn, NSW, was severely drought affected and therefore lambs were often ultrasound scanned before being sold as stores instead of finished and carcase data obtained.

Background

Ref 26a

Project aims:

- To progeny test LAMBPLAN recorded Terminal sire rams per year for three years.
- Increase Merino Validation Project (MPV) linkage through inclusion of Merino rams for progeny measurement of carcase, growth and wool traits per year for three years.
- Develop a genetic resource of sires to progress Elders' seedstock clients, commercial prime lamb and wool clients and end users.
- Increase knowledge of relationships between Viascan and ultrasound carcase measurements.
- To increase awareness of the economic value of superior LAMBPLAN and MGS evaluated genetics to Elders' staff, seedstock clients, commercial clients and end users.

Terminal Sire Selection

- Selection of Terminal sire rams using the mate selection program Total Genetic Resource Management (TGRM) (Best strategic fit).
- Terminal sire rams included 2 reference sires (sires that will have had or will have high use in LAMPBPLAN seed-stock flocks).

Merino Sire Selection

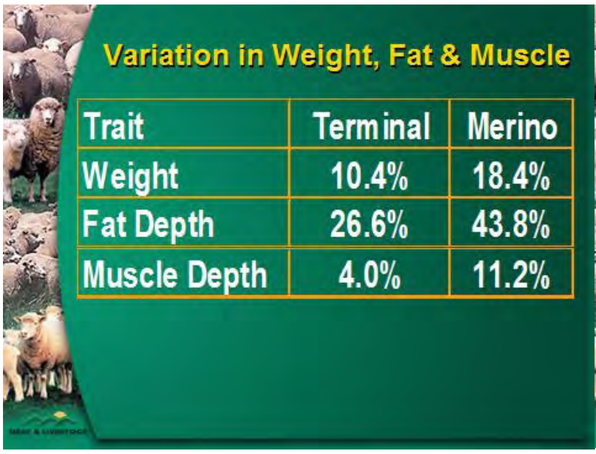
- Selection of new MVP rams using from Elders Merino client base (designed to create MVP Linkage).
- Selection of 2 high accuracy proven Merino sire rams as reference sires (as above).

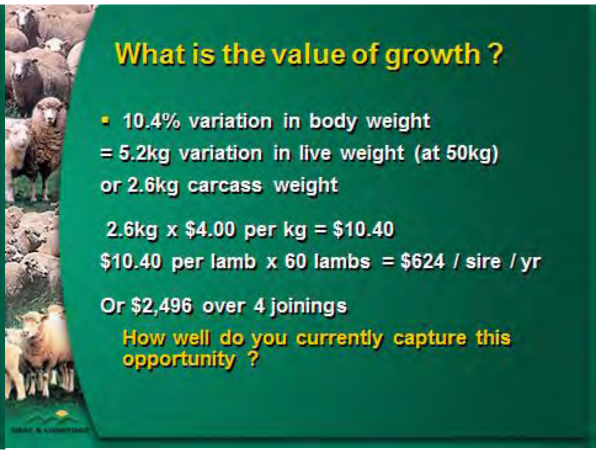
A demonstration day was conducted and results presented there. The results from the trial were submitted to Sheep Genetics for the creation of Estimated Breeding Values and improved linkages.

Results

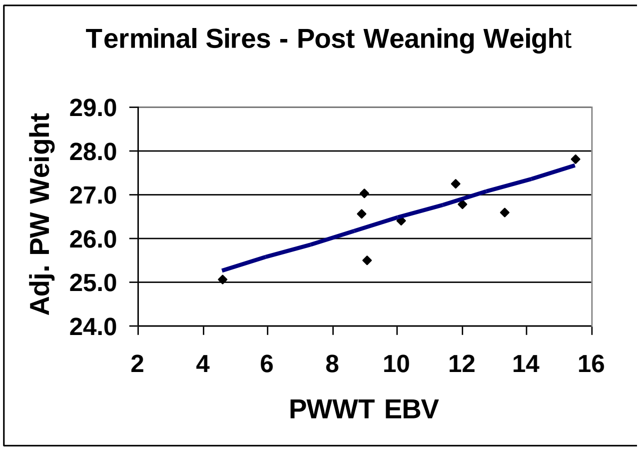
Ref 26b

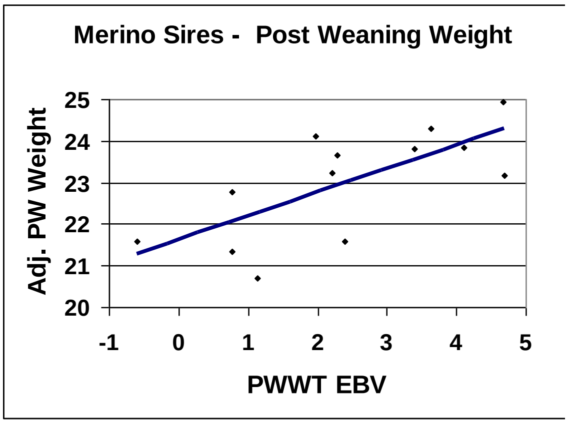
A key learning outcome is the genetic range for the traits being measured. Genetic range is the selection opportunity and we can calculate an economic value from this range:

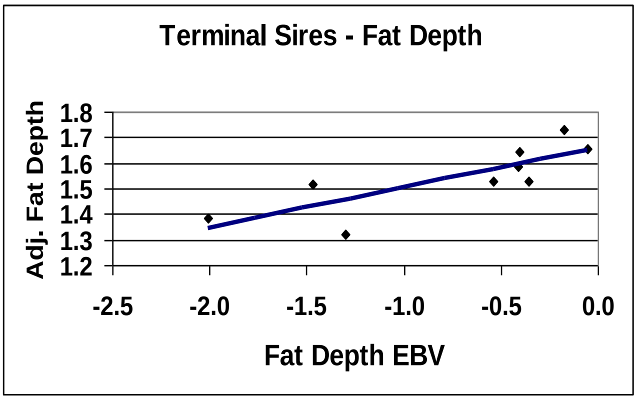


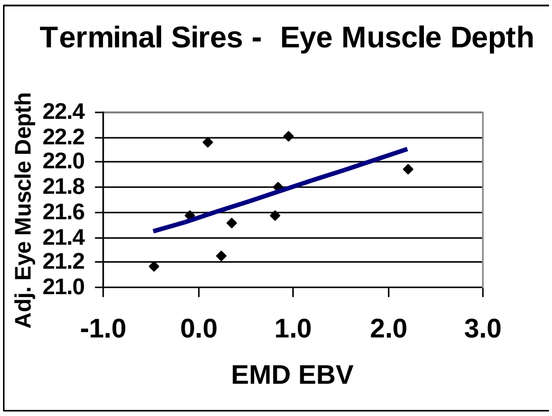


The following comparison of progeny results with sire breeding values where progeny performance is adjusted for variables such as sex and birth type.









Test rams, being of low accuracy, showed that the average EBV of the team produced progeny with averages close to the predicted average of the team. This demonstrated the utility of EBVs to select commercial ram teams and generated thinking on how young high indexing rams could be used in seedstock programs.

Number	27
Name	**Elmore – Ewes for the future**
Traits researched	FD, CFW, WT, RR, EMD, FAT, HSCW, Visual assessment
Date	2009 – ongoing
Target audience	Ram buyers
Target	Meat, Maternal and Wool
Source	Elmore Field Days
Contact	Kieran Ransom, M: 0419 320 824 E: kieran.ransom@bigpond.com
What's missing	There will be two more years of data, 2012 and 2013

Further Information

Permission	Yes
Summary of resources	2009, 2010 and 2011 results
File and format	**27a** *summary* Elmore EwesFTF 2011-12-31 Section 1 SUMMARY.pdf **27b** *full results* Elmore EwesFTF 2011-12-31 Section 1-3 FULL REPORT.pdf

Key facts

- 5 maternal types compared for wool and meat profitability over 4 lambing seasons, profitability over 5 lambing seasons. Ewes first joined as ewe lambs, followed by 4 adult lambings.
- A fourth joining has taken place with measurements to be collected in 2012/2013

Note

- Ewe trials, wether trials and sheep productivity trials emphasise a large variation in the genetic performance between animals. Superior performance in these trials is at times attributed to the incorporation of advanced genetic technologies like breeding values and indexes or the inclusion of objective measurement in selection programs. They also stress the need to use tools that describe genetic differences when making ram and sire choices.

Useful Information

- 5 maternal types to be compared for lambing percentage, lamb growth rates and wool production (42 ewes per breed type – with three equal sources of genetics per breed type (14 per source)).
- Comparison will be made over 4 lambings.
- Results here presented are for the second and third lambings (2010 and 2011 drop) – see special note below:

- *Note: These results are from ewes that were born over a four month period and reared in very different environments until January 2009 until their first joining as ewe lambs in late February 2009. The first two adult lambings are the result of joining in late December and then early December the following year. The breeds might differ in their seasonality of breeding, for example some groups may have higher lambing percentages from later joining. Thus the 2012 lambing will be from a February joining.*

Background

In January 2009, the Elmore Field Days trial, Ewes for the Future – Lambs, Wool and Profit, began. The trial aims to compare the merits of five alternative sheep types. The results will assist sheep producers determine the merits of a number of ewe breed alternatives for prime lamb production. The main characters of interest are lambing percentages, lamb growth rates and wool production.

At the start of the trial, a total of 210 ewe lambs were delivered to the site. The five breed-types are each represented by 42 ewes. Each breed type group was randomly selected from three properties, with 14 ewe lambs per property after an allowance for culling. The ewes are run together as one mob except at lambing. It is planned to run the trial for at least four lambings.

The ewe breed types are:

Crossbred ewes. The most common prime lamb mother in northern Victoria. Ewes were sourced with the help of the SuperBorders group, a group within the Border Leicester breed society using Sheep Genetics techniques to help breed better Border Leicester rams.

Peppin Merino. The second most common prime lamb mother in northern Victoria. Ewes were sourced with the help of the Loddon Valley Stud and Merino Breeders Association.

Centre Plus Merino. Centre Plus is a group breeding scheme and registered Merino stud in Central West NSW that aims to produce dual purpose sheep. This Merino strain has achieved a good reputation from the high dual purpose and fine wool index values on the Sheep Genetics website.

Dohne. The Dohne is a dual-purpose breed developed in South Africa using Peppin type Merino ewes and German Mutton Merino sires. They have been selected for high fertility, rapid lamb growth rate and fine wool. There is a high level of farmer interest in this dual purpose breed. Sheep were sourced with the assistance of the Australian Dohne Breeders' Association.

SAMM. The Prime SAMM (South African Meat Merino) is a dual purpose sheep originally bred in South Africa to produce heavy slaughter lambs at a young age as well as good quality wool. The breed society is aiming at 60 per cent meat and 40 per cent wool in members breeding programs. Sheep were sourced with the assistance of the Prime SAMM Breeders' Society of Australia.

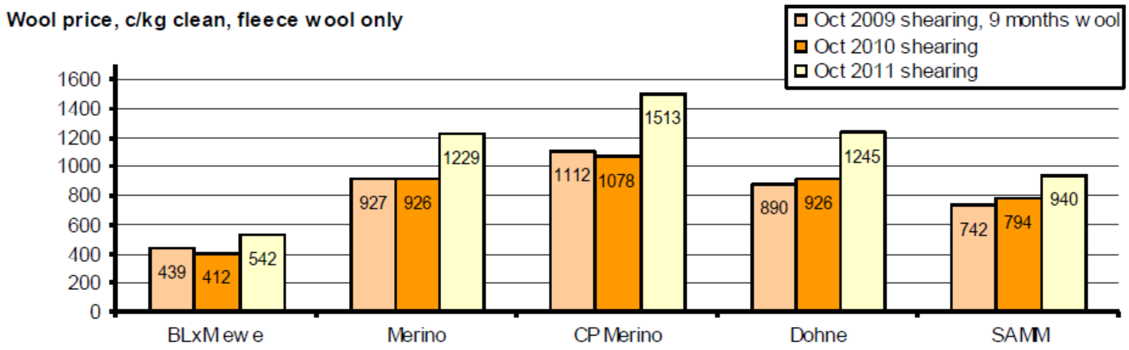
Ewe lambs of the 2008 drop were delivered to the Elmore Field Days by early January 2009. They were fed a high quality diet to reach a suitable joining weight in late February 2009, when they were joined to White Suffolk rams. The following breeding season started with joining on 29 Dec 2009. The peak of lambing was on 13 June 2010 and the first batch of 92 lambs was sold on 5 November at an average weight of 49kg.

***Note**: These results are from ewes that were born over a four month period and reared in very different environments until January 2009 until their first joining as ewe lambs in late February 2009. The first two adult lambings are the result of joining in late then early December. The breeds might differ in their seasonality of breeding, for example some groups may have higher lambing percentages from later joining. Thus the 2012 lambing will be from a February joining.*

Results *Ref 27b*

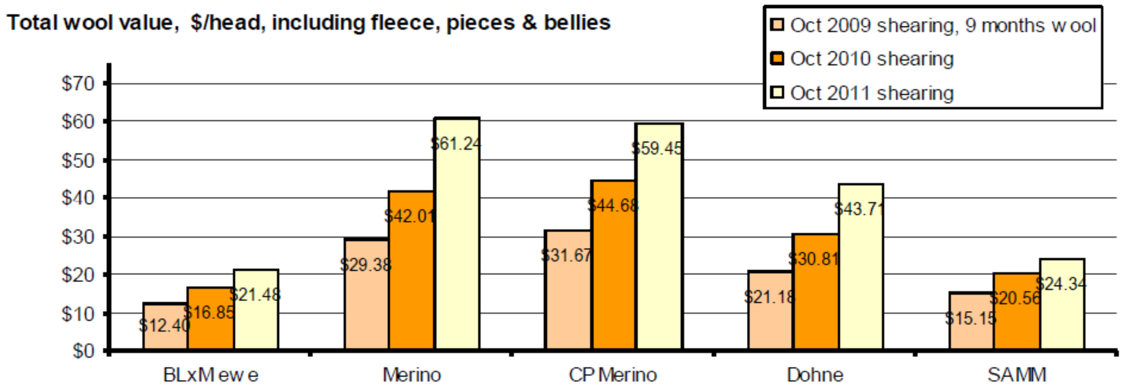
6.4 Wool price

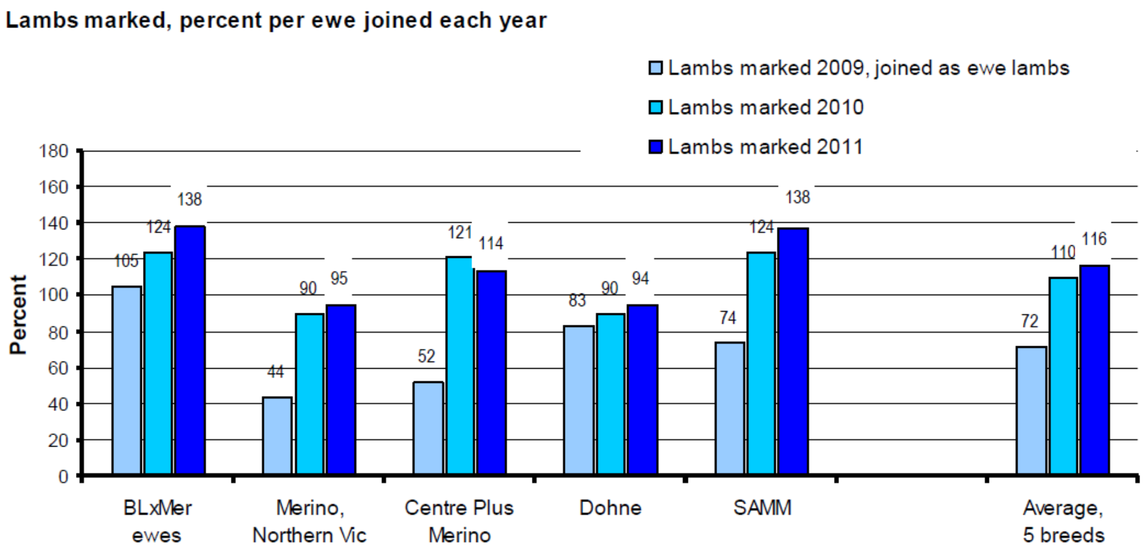
Wool prices are the average for each diameter and type over the previous 12 months.



6.5 Wool returns

Wool returns are calculated using average wool prices for each diameter and type over the previous 12 months.





Lamb carcase prices given are the average figures for the previous year for trade and heavy lambs, as calculated from the MLA Market Weekly newsletter. The same price per kilo was used for all breeds because the lighter lambs were still steadily gaining weight after the first draft was sold on 5 Nov 2010. Skin prices are also average prices for the previous year of sucker lamb skins; again sourced from the MLA Market Weekly newsletter.

Summary of results for 2010 drop

2010 season, Total returns, wool & lamb					
Ewe breed	**BL x Merino cross**	**Merino Northern Vic**	**CP Merino**	**Dohne**	**SAMM**
Average lamb weight, 5 Nov 2010, kg	48.3	44.1	45.7	45.1	47.3
Dressing percentage (assumed), %	49	49	49	49	49
Lamb price, av Dec2009-Nov2010, $/kg	$4.75	$4.75	$4.75	$4.75	$4.75
Estimate lamb carcase value, $/lamb	$112.42	$102.64	$106.37	$104.97	$110.09
Skin value, av price Dec2009-Nov2010, $/head	$12.00	$12.00	$12.00	$12.00	$12.00
Total lamb value, carcase & skin, $/head	$124.42	$114.64	$118.37	$116.97	$122.09
Lambs marked, %	124	90	121	90	124
Lamb value per ewe, adjusted for lambing percent, $/ewe	$154.28	$103.18	$143.22	$105.27	$151.39
Wool value per ewe, $/ewe	$16.85	$42.01	$44.68	$30.81	$20.56
Total returns, wool & lamb, $/ewe	$171.13	$145.19	$187.90	$136.08	$171.95
Key figures used to calculate the DSE rating per ewe-lamb unit are the ewe weight and lambing percentage, see below					
Ewe weight, year average, fleece free, kg	67.6	53.8	60.0	61.2	69.9
DSE – Dry sheep equivalent estimate per ewe & lamb unit (takes into account ewe weight, lamb weight and lambing percentage)	2.71	1.94	2.43	2.12	2.74

Summary of results for 2011 drop

Total returns, wool & lamb, 2011 season					
Ewe breed	**BL x Merino cross**	**Merino Northern Vic**	**CP Merino**	**Dohne**	**SAMM**
Average lamb weight, 20 Oct 2011, kg	48.6	47.2	47.9	48.3	49.5
Dressing percentage of lambs, %	48.7%	48.1%	47.7%	49.4%	49.1%
Lamb price, av Dec2010-Nov2011, $/kg	$5.32	$5.32	$5.32	$5.32	$5.32
Estimate lamb carcase value, $/lamb	$125.91	$120.88	$121.55	$126.94	$129.30
Skin value, av price Dec2009-Nov2010, $/head	$18.00	$18.00	$18.00	$18.00	$18.00
Total lamb value, carcase & skin, $/lamb-head	$143.91	$138.88	$139.55	$144.94	$147.30
Lambs marked, %	138%	95%	114%	94%	138%
Lamb value per ewe, adjusted for lambing percent, $/ewe	$198.60	$131.94	$159.09	$136.24	$203.27
Wool value per ewe, $/ewe	$21.48	$61.24	$59.45	$43.71	$24.34
Total returns, wool & lamb, $/ewe	$220.08	$193.18	$218.54	$179.95	$227.61
Key figures used to calculate the DSE rating per ewe-lamb unit are the ewe weight and lambing percentage, see below					
Ewe weight, year average, fleece free, kg	80.9	64.3	69.6	69.9	79.6
DSE – Dry sheep equivalent estimate per ewe & lamb unit (takes into account ewe weight, lamb weight and lambing percentage)	3.28	2.32	2.69	2.45	3.28

Note: It is invalid to estimate the relative profitability of breed groups by dividing the total returns per ewe by the DSE rating as it does not take into account the monthly pasture growth, feed supply and the feed needs of the sheep. Gross margins analyses of these systems will be done using the GrassGro computer program – a program that can better estimate the profitability of these dynamic systems over a range of years of variable rainfall, prices, stocking rates and management systems. For example at lower stocking rates there may be little feed stress penalty from large framed ewes with high lambing percentages; while at higher stocking rates lamb growth may be penalised. The returns from wool may then become an important factor.

Number	28
Name	**Qplu$ Project**
Traits researched	**FD, CFW, Index, Fleece $, Carcase $**, All fleece traits, Growth, all carcase traits, all reproduction traits, gross margin, all visual wool and conformation traits and feed intake
Date	1993-2007
Target audience	Ram breeders and buyers
Target	Wool, dual purpose
Source	DPI – Sue Mortimer , AWI and MLA
Contact	Sue Mortimer, NSW DPI, E: sue.mortimer@dpi.nsw.gov.au
What's missing	Extension slides and messages could be simplified

Further Information

Permission	Yes
Summary of resources	Open day proceedings (6 in total), Project newsletters (6 in total), MMFS PowerPoint presentation Field day presentation Final report to AWI Primefacts (3 in total)
File and format	**28a** PowerPoint Slides – Pop_wool_160708 variation.ppt **28b** *Open day proceedings 2007* CE Pope (editor), Trangie Qplu$ Merinos – Open Day 2007.pdf **28c** *Open day proceedings 2006* CE Pope (editor), Trangie Qplu$ Merinos – Open Day 2006.pdf **28d** *Final report to AWI* Q Plus Final Report.pdf **28e** *Newsletters* A few selected lines newsletters 5-8.pdf **28f** *prime facts* Bird-Gardiner, T., Casey, A., Taylor, P., Mortimer, S., (2007) Using EBVs

	and selection indexes to meet your Merino breeding objective. PRIMEFACT 580, ISSN 1832-6668, NSW DPI. Available on-line. Taylor, P., Mortimer, S., Bird-Gardiner, T., Atkins, K. (2007) Merino breeding objectives & selection indexes to increase wool profit. PRIMEFACT 579, ISSN 1832-6668, NSW DPI. Available on-line. Taylor, P., Bird-Gardiner, T., Mortimer, S., Atkins, K. (2007) Selection indexes work for all Merino strains & breeding objectives. PRIMEFACT 578, ISSN 1832-6668, NSW DPI. Available on-line. qplus primefacts (579 580 578).pdf **28g** QP 2007 Pat.ppt

Key Findings

- Using genetic technologies, all Merino breeding flocks regardless of bloodline or wool type, can make a high rate of genetic progress for any one of a wide range of breeding objectives, including breeding objectives where economically important traits are unfavourably correlated.
- Genetic technologies allow genetic tracking and accurate prediction of genetic progress.
- Breeding values are a more accurate evaluation of the genetic performance of a trait than measured performance alone.
- The work also involved a review of returns from a variety of market conditions and the implications for setting breeding objectives.
- This project also saw the production of considerable extension material and messages to support the uptake of best practice sheep breeding technologies (***ref 28c*** and listed in ***28d***).

Useful Information

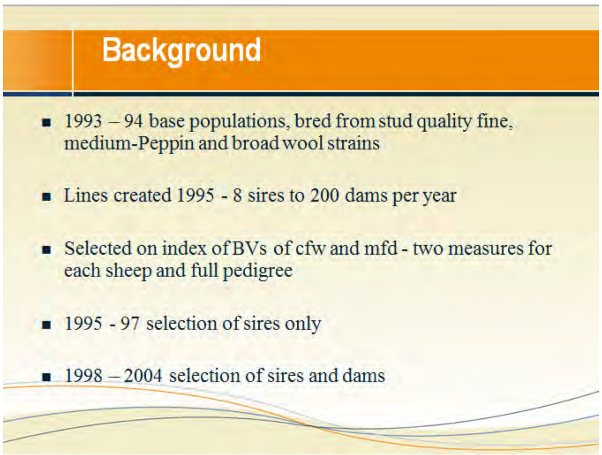
- 10 years of selection for FD and CFW based on **within-flock EBVs** using differing selection emphases (3%MP, 8%MP, 15%MP indices) over three Merino strains.
- 200 ewes per line, mated annually to 8 rams.
- Annual extensive assessment of objective and subjective attributes, including classer's grade.
- Carcase (abattoir), feed intake and reproduction records were kept.
- Gross margin analysis, carcase and fleece values were generated.
- Results for attributes other than FD and CFW are due to correlations with these traits.

Background

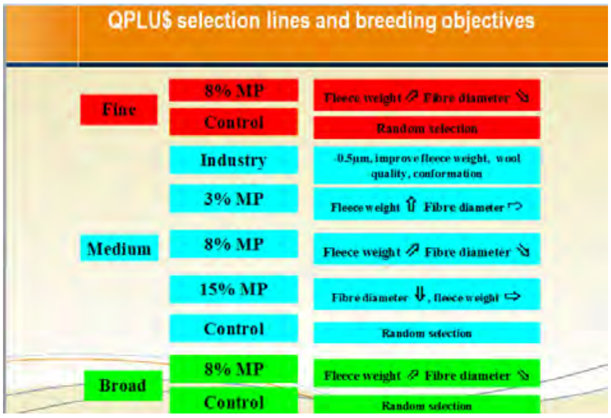
The primary research objective of the Qplu$ project was to demonstrate that simultaneous improvements in fleece weight gain and fibre diameter reduction are possible in all Merino strains (8% MP lines compared with the control lines of each strain) and that, within that genetic breeding objective, there is latitude to vary the rates of progress in each trait by varying the selection emphasis on each (3% MP and 15% MP medium wool lines compared with the medium wool control line).

A secondary but important objective of the project was to monitor lifetime changes in a comprehensive list of traits that impact on the costs of production and revenues of the wool growing enterprise. These include fleece and fibre properties, carcase traits, feed intake and visually assessed traits. The QPLU$ project's major technology transfer objective was to increase adoption of efficient performance-based breeding technology to the Merino ram breeding industry through demonstration of the process and outcomes of index selection.

Ref 28g



Ref 28g **Selection lines and their objectives over the fine, medium and broad wool Merino strains.**



Results

ref 28d Carcase

- There were generally small and variable but sometimes significant changes in carcase characteristics.
- Any negative change found can be easily accounted for using a selection index which includes those traits.
- Other than for carcase weight, the changes observed are of minor commercial significance to the current slaughter value of surplus animals.
- In the longer term, the genetic parameters estimated from the Qplu$ and other data have been used by Safari *et al* (2007, 2008) and Greeff *et al* (2008) which use data from across the Merino resource flocks.

Table 5 Control line means and selection line deviations for body weight and carcass traits of 2001-2004 drop rams

	Fine wool		Medium-Peppin					Broad wool	
Trait	8%	C	Ind.	3%	8%	15%	C	8%	C
Pre-slaughter weight (kg)	+2.1	62.1	+3.1✓	+0.6	+0.3	-0.2	68.1	-0.6	78.5
Hot carcass weight (kg)	0	25.2	+1.0	-0.3	+0.3	-0.4	26.5	-1.4✗	31.6
Dressing percentage (%)	-1.2✗	40.1	-0.1	-0.6✗	0	-0.4	38.6	-1.3✗	39.9
Tissue depth GR site (mm)	-1.3✗	9.4	-0.8	-0.6	-0.6	-0.4	9.1	-1.6✗	10.5
Eye muscle area (cm^2)	-0.5	14.0	1.0✓	-0.3	+0.8✓	-0.1	14.6	-0.8✗	16.1
Muscle lightness	-0.4	34.6	-0.6	0	-0.3	-0.4	33.8	+0.9✓	33.5
Muscle redness	+0.1	19.5	-0.4	-0.8✗	-0.2	-0.5	19.9	+0.6	19.4
pH Loin	+0.1*	5.9	+0.1*	+0.1*	+0.1*	+0.1*	5.9	0	5.9

✓ denotes a significant improvement compared to the Control line of that strain., ✗ denotes a significant deterioration compared to the Control line of that strain, * denotes a significant difference from the Control line of that strain (P<0.05)

ref 28d Feed intake

- Despite differences in bodyweight and wool production, estimates of dry matter intake (neither per head nor per unit body weight) identified any significant variation in feed intake between lines and strains.
- There were significant strain affects however, the fine strains consuming significantly less per head than medium and broad wool ewes.
- Within strains, the selected lines are producing heavier fleeces of finer fibre diameter for the same amount of pasture consumed as the control lines.

Table 6 Control line means and selection line deviations for body weight and feed intake of 1997 – 2001 drop ewes

	Fine wool		Medium-Peppin					Broad wool	
Trait	8%	C	Ind.	3%	8%	15%	C	8%	C
Live weight (kg)	-0.8	62.3	+2.9✓	+2.9✓	+1.1	+1.2	65.6	-1.6	75.8
Intake (kg DM/day)	+0.03	2.09	+0.20	-0.05	+0.06	+0.15	2.23	-0.19	2.53
Intake per kg LW (g/kg/day)	+1.3	34.3	+1.3	-2.2	-0.1	+1.4	34.8	-1.5	34.2

✓ denotes a significant improvement compared to the Control line of that strain. (P<0.05)
✗ denotes a significant deterioration compared to the Control line of that strain (P<0.05)

ref 28d Clean Fleece Weight and Fibre Diameter

- Table 1 records responses to selection for fleece weight and fibre diameter. These are expressed as deviations from the control lines for hoggets and for adult ewes in each selection line.
- For hoggets, estimates of response based on mean breeding value deviations (hbv) are also given. Although estimates of responses in hogget fleece weight by either method were generally very similar, responses in fibre diameter were usually underestimated by the breeding value approach.
- Based on the best estimates available in the early 1990s for breeding value estimation, heritabilities were assumed of 0.4 and 0.5 for clean fleece weight and mean fibre diameter respectively.
- Genetic analyses of all current QPLU$ data has provided flock specific estimates of heritability for each trait of 0.4 and 0.66 respectively. The difference between assumed and actual heritability for fibre diameter explain most of the disparities between responses in fibre diameter estimated by each method.

- **All selection lines have demonstrated large improvements in fleece weight and/or fibre diameter in line with predetermined breeding objectives.**
- The incremental improvements in fleece weight and fibre diameter observed across the drops have accumulated and are permanent.
- Traits with unfavourable genetic relationships, such as fleece weight and fibre diameter, can be improved simultaneously using appropriate selection indices.
- Within flock selection based on measured performance with or without visual assessment has delivered predictable and substantial improvements that have increased the profitability of the Qplu$ selection lines.

Table 1 Control line means and selection line deviations for clean fleece weight and mean fibre diameter for 2004 drop hogget (h, h_{bv}) and 2003 drop adult (a) ewes

		Fine wool		Medium wool					Broad wool	
Trait		8%MP	C	Ind.	3%MP	8%MP	15%MP	C	8%MP	C
Clean fleece weight (kg)	h_{bv}	+0.5	-	+0.6	+0.8	+0.6	+0.3	-	+0.5	-
	h	+0.7	3.5	+0.5	+0.7	+0.6	+0.04	4.4	+0.6	5.0
	a	+1.0	3.6	+0.9	+1.1	+0.9	+0.1	4.9	+1.0	5.4
Mean fibre diameter (µm)	h_{bv}	-1.4	-	-1.0	-0.3	-1.5	-2.4	-	-1.6	-
	h	-1.7	19.8	-0.9	-0.5	-1.9	-3.2	20.8	-2.6	23.9
	a	-1.4	20.3	-1.1	-0.5	-2.0	-3.6	22.0	-2.4	25.2

(ref 28b) Results expressed as whole values and adult ewes as mixed age ewes

Table 1 Clean fleece weight, mean fibre diameter and body weight of the 2004 drop (h) and mixed age adult ewes (a) of each line

Strain		Fine wool		Medium wool					Broad wool	
Trait		8%	C	Ind.	3%	8%	15%	C	8%	C
Clean fleece weight (kg)	h	3.9✓	3.3	5.0✓	5.4✓	5.1✓	4.7✓	4.5	5.8✓	5.0
	a	4.4✓	3.4	5.4✓	5.4✓	5.4✓	4.9	4.7	6.0✓	5.0
Mean fibre diameter (µm)	h	18.1✓	19.2	19.5✓	20.1✓	18.7✓	17.7✓	20.4	21.4✓	24.1
	a	19.4✓	20.3	20.9✓	21.3✓	20.3✓	18.9✓	22.0	23.0✓	25.4
Body weight (kg)	h	48.7✓	46.8	53.1✓	51.9✓	53.0✓	50.6	49.7	58.7✗	60.7
	a	55.6	55.7	62.2✓	61.7✓	60.6✓	59.7	57.7	68.4	67.9

✓denotes a significant improvement compared to the Control line of the relevant strain. ($P<0.05$)
✗denotes a significant deterioration compared to the Control line of the relevant strain ($P<0.05$)

ref 28d other fleece results

As a consequence of the selection imposed on fleece weight and fibre diameter within the Qplu$ lines:

- There were variable responses in staple strength, with the only significant change a 4.8 N/ktex increase in the fine selected line.
- Staple length generally increased in the selected lines.
- Yield increased significantly in the fine and broad 8% lines.

Table 2 Control line means and selection line deviations for staple length, staple strength and percent mid-break of the 2004 drop (h) and mixed age adult ewes (a) of each line

Strain		Fine wool		Medium wool					Broad wool	
Trait		8%	C	Ind.	3%	8%	15%	C	8%	C
Length (mm)	h	+ 5	98	+ 2	+ 5	+ 3	-1	103	+ 6✓	115
	a	+4✓	93	+ 1	+ 1	- 1	- 6✗	101	0	111
SS (N/ktex)	h	+ 4.8✓	26.3	- 1.1	+ 2.3	- 1.4	- 3.1	33.5	+ 2.7	27.7
	a	+ 4.8✓	28.2	+ 4.1✓	+ 4.8✓	- 0.9	- 0.8	25.7	+ 0.3	29.9
Mid break (%)	h	- 5	49	+ 4	- 14✓	+ 7	+ 10	48	- 9	26
	a	+ 9	42	+ 6	+ 9	+ 12✗	+ 8	26	+ 3	31

✓denotes a significant improvement compared to the Control line of the relevant strain. (P<0.05)
✗denotes a significant deterioration compared to the Control line of the relevant strain (P<0.05)

- Among the 2004 drop ewes, there was evidence of improvements in fleece structure (staple and crimp definition), dust penetration and classer grade within the selected lines of each strain. The only significant deterioration observed was a slight (one score) increase in the greasy colour of the selected fine wool line. The scale used for greasy colour scoring of QPLU$ samples was on a 1-8 scale, whereas a 1-5 score would be likely to be used today. A one score change in the 1-8 scale may be equivalent to a smaller change on a 1-5 scale.

Table 4 Control line means and selection line deviations for style traits and classer grade of the 2004 drop (h) mixed age (a) ewes

		Fine wool		Medium wool					Broad wool	
Trait		8%	C	Ind.	3%	8%	15%	C	8%	C
Dust penetration (% from tip)	h	-5.0✓	49.0	+0.2	-0.5	-3.0✓	-0.9	41.0	+0.1	43.7
	a	-7.7✓	53.5	-0.3	-0.6	-2.5✓	+0.6	38.7	+1.9	42.0
Crimp frequency (n/25mm)	h	-1.9*	14.9	-0.6	-0.6	-0.4	+0.5	10.1	-0.1	8.5
	a	-2.5*	15.7	+0.1	-0.4	-0.2	+0.7*	10.0	-0.2	8.7
Crimp definition (1-6)	h	-0.2	3.7	0	-0.1	-0.1	-0.3	3.6	-0.4✓	3.8
	a	0	3.0	-0.3✓	-0.2✓	-0.4✓	-0.6✓	3.6	-0.4✓	3.6
Greasy colour (1- 8)	h	+1.1✗	2.6	+0.2	+0.1	-0.1	-0.3	5.1	0	6.2
	a	+0.7✗	2.0	+0.3	+0.1	+0.4✗	+0.4✗	4.0	-0.3	4.9
Staple definition (1- 6)	h	-0.9✓	4.1	-0.5✓	-0.2	-0.3	-0.8✓	3.6	-0.9✓	3.8
	a	-0.3✓	3.4	-0.4✓	-0.2	-0.4✓	-0.8✓	3.7	-0.3✓	3.8
Tip shape (1-3)	h	+0.5*	1.2	0	0	0	+0.1	1.2	+0.1	1.4
	a	0	1.0	0	0	0	0	1.1	+0.2*	1.2
Classer grade (1–4)	h	-0.5	3.0	-0.1	-0.1	-0.4	+0.1	2.8	-0.9✓	3.1
	a	-0.9✓	2.9	-0.4✓	-0.4✓	-0.3	-0.1	2.4	-1.0✓	2.8

✓ denotes a significant improvement compared to the Control line of that strain. (P<0.05) ✗ denotes a significant deterioration compared to the Control line of that strain (P<0.05) * denotes a significant difference from the Control line of that strain (P<0.05)

ref 28d reproduction results

The genetic correlations between weaning percentage and the traits under selection suggest that some decline in reproduction should be expected in these experimental lines and would result more from selection for increased fleece weight than for finer fibre diameter. Although for both traits the genetic correlations with weaning percentage are unfavourable, the genetic antagonism is stronger with fleece weight (rg -0.26) than with fibre diameter (rg 0.06). To place these observations in perspective, we would expect reductions of around 9% lambs weaned per ewe joined after 10 years of single trait selection for clean fleece weight of the intensity applied in the Qplu$ lines. Additional selection for fibre diameter might be expected to increase the rate of decline in weaning percentage somewhat. In stud and commercial flocks, this could be offset by applying moderate additional selection on reproduction traits or traits related to reproduction. This could be readily achieved via appropriate weightings in a selection index or independent culling of ewes that fail to rear lambs. The authors suggest that, due to severe drought conditions, some environmental factors are also likely to have contributed to the lamb survival results.

Table 7 Control line means and selection line deviations for components of reproduction for the 1999 – 2002 drop ewes

	Fine wool		**Medium wool**					**Broad wool**	
Trait	**8%**	**C**	**Ind.**	**3%**	**8%**	**15%**	**C**	**8%**	**C**
Ewes lambing/ewe joined (%)	0	74	0	0	0	+3	85	-4	77
Ewes twinning/ewe joined (%)	-3	36	+3	+3	-1	+3	47	-5	48
Lambs born/ewe joined (%)	-2	110	+3	+2	-2	+4	134	-10	129
Lamb survival/lamb born (%)	-12✕	78	-1	-4	-6✕	0	76	-5	76
Lambs weaned/ewe joined (%)	-14✕	84	+2	-5	-9✕	+4	100	-14✕	96

✓ denotes a significant improvement compared to the Control line of that strain. (P<0.05)
✕ denotes a significant deterioration compared to the Control line of that strain (P<0.05)

Fleece value, carcase value and gross margin analysis (ref 28d)

- Low premium market prices of 2006/2007 were used for fleece value calculation (see figure 3 reported later).
- High premium market prices of 2000/2001 are reported for comparison.
- Wool values per head account for the proportion and prices of total wool weight sold in lines of fleece, pieces, bellies and locks.
- Carcase values were based on selection line averages for ewe live weight, dressing percentages and fat scores based on the ram carcase data presented in ***ref 28c***.
- Carcase prices provided by Meat and Livestock Australia are based on over the hooks quotations averaged over the previous three years. Skin prices were based on quotations in *The Land* newspaper for a 24 kg carcase.
- Variable costs per head of $24.84 per annum are assumed across both age groups, based on NSW Department of Primary Industries estimates for 19-23 micron breeding ewes.
- Gross margins are presented on a dry sheep equivalent (DSE) basis by adjusting gross margins per head to a common body weight of 45 kg across all lines. Income per head and lifetime gross margins in the current market are presented in Table 13.

The input data is based on phenotypic fleece weights, body weights and fibre diameters (Table of all 2004 drop ewes and the random sample of the 100 breeding ewes (2000 - 2003 drops) line for which we have the necessary wool quality measurements to fully value fleeces.

Table 12 Clean fleece weight, mean fibre diameter and body weight of the 2004 drop (h) and ' mixed age adult ewes (a) of each line

Strain		Fine wool		Medium wool					Broad wool	
Trait		8%	C	Ind.	3%	8%	15%	C	8%	C
Clean fleece weight (kg)	h	3.9✓	3.3	5.0✓	5.4✓	5.1✓	4.7✓	4.5	5.8✓	5.0
	a	4.4✓	3.4	5.4✓	5.4✓	5.4✓	4.9	4.7	6.0✓	5.0
Mean fibre diameter (µm)	h	18.1✓	19.2	19.5✓	20.1✓	18.7✓	17.7✓	20.4	21.4✓	24.1
	a	19.4✓	20.3	20.9✓	21.3✓	20.3✓	18.9✓	22.0	23.0✓	25.4
Body weight (kg)	h	48.7✓	46.8	53.1✓	51.9✓	53.0✓	50.6	49.7	58.7✗	60.7
	a	55.6	55.7	62.2✓	61.7✓	60.6✓	59.7	57.7	68.4	67.9

✓denotes a significant improvement compared to the Control line of the relevant strain. ($P<0.05$)
✗denotes a significant deterioration compared to the Control line of the relevant strain ($P<0.05$)

Table 13 Control line means and selection line deviations for income per head and gross margin per dse for a low micron premium market (2006 – 2007)

Strain		Fine wool		Medium wool					Broad wool	
		8%	C	Ind.	3%	8%	15%	C	8%	C
Wool value ($ / head)	h	8.44	27.30	6.94	7.99	10.73	10.43	35.41	10.46	30.48
	a	10.80	26.06	7.06	6.48	7.69	8.34	33.74	13.53	28.97
Wool value ($ / dse)	h	7.21	26.51	4.70	6.32	8.06	9.27	32.78	9.25	24.58
	a	9.23	22.27	4.02	3.81	5.30	6.10	28.11	9.79	21.46
Lamb /year ($)		-2.80	16.80	0.40	-1.00	-1.80	0.80	20.00	-2.80	19.20
Adult carcass ($)		-1.24	43.86	3.54	2.50	2.28	1.16	45.44	-1.16	53.47
Adult skin ($)		0.00	8.00	0.00	0.00	0.00	0.00	8.00	0.00	8.00
GM /head/year ($)		7.84	25.28	8.07	6.49	7.32	9.63	35.92	10.44	32.09
GM /dse/year ($)		6.70	21.61	4.71	3.73	4.94	7.10	29.93	7.50	23.77

Table 14 Control line means and selection line deviations for income per head and gross margin per dse for a high micron premium market (2000 – 2001)

Strain		Fine wool		Medium wool					Broad wool	
		8%	C	Ind.	3%	8%	15%	C	8%	C
Wool ($)/head	h	24.52	29.70	14.40	7.44	29.20	63.05	26.75	6.53	21.31
	a	18.18	19.75	7.94	5.75	9.98	29.02	21.45	6.63	21.36
Wool ($)/dse	h	22.32	28.83	11.65	6.03	24.74	57.62	24.77	5.82	17.19
	a	15.54	16.88	5.27	3.71	7.47	23.16	17.88	4.76	15.82
Lamb ($)/year		-2.80	16.80	0.40	-1.00	-1.80	0.80	20.00	-2.80	19.20
Adult carcass ($)		-1.14	40.10	3.24	2.29	2.09	1.06	41.54	-1.06	48.89
Adult skin ($)		0.00	8.00	0.00	0.00	0.00	0.00	8.00	0.00	8.00
GM /head/year ($)		16.98	19.96	10.20	5.75	12.80	36.68	23.58	4.16	23.25
GM /dse/year ($)		14.51	17.06	6.95	3.62	9.69	29.34	19.65	2.93	17.22

Wool returns under market volatility

Work completed by Kevin Atkins and published in ***ref 28d*** looked at Market Volatility. He used the results from 10 years of selection in the Medium wool lines to show the gross margin outcomes under different market scenarios for the alternative selection approaches. Markets were from 1997-2006 (moderate, high MP and low MP – see figure 3 below).

Regardless of market scenario and breeding objective, all medium wool selected lines have increased in fleece value relative to the control line. Under low micron premium markets there was relatively little variation among the lines in fleece value which was driven more by responses in fleece weight than fibre diameter. In contrast, under high micron premiums the fleece value responses diverged markedly between lines driven by both fleece weight and fibre diameter.

Figure 3 Prices for mean fibre diameter – 1997 to 2006

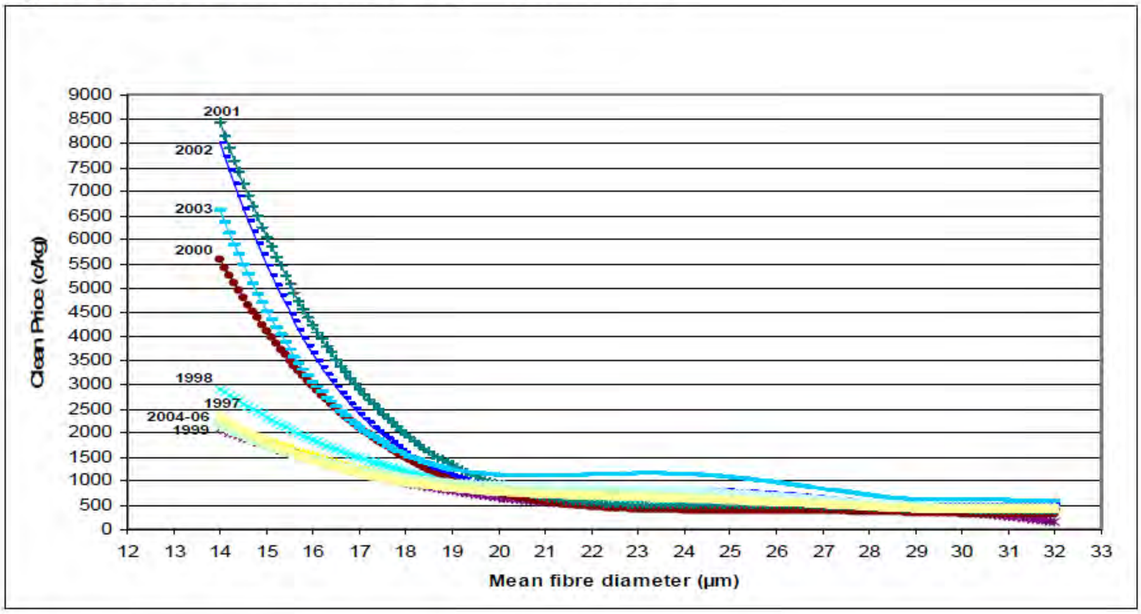


Figure 4 Increases in fleece value above controls in the low micron premium market

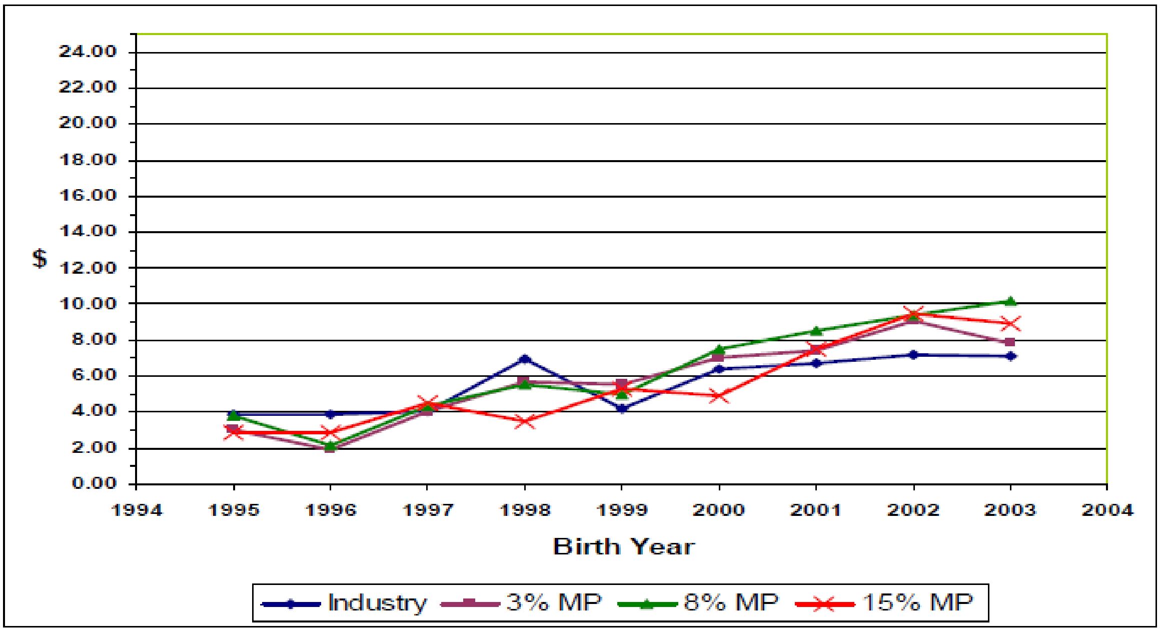
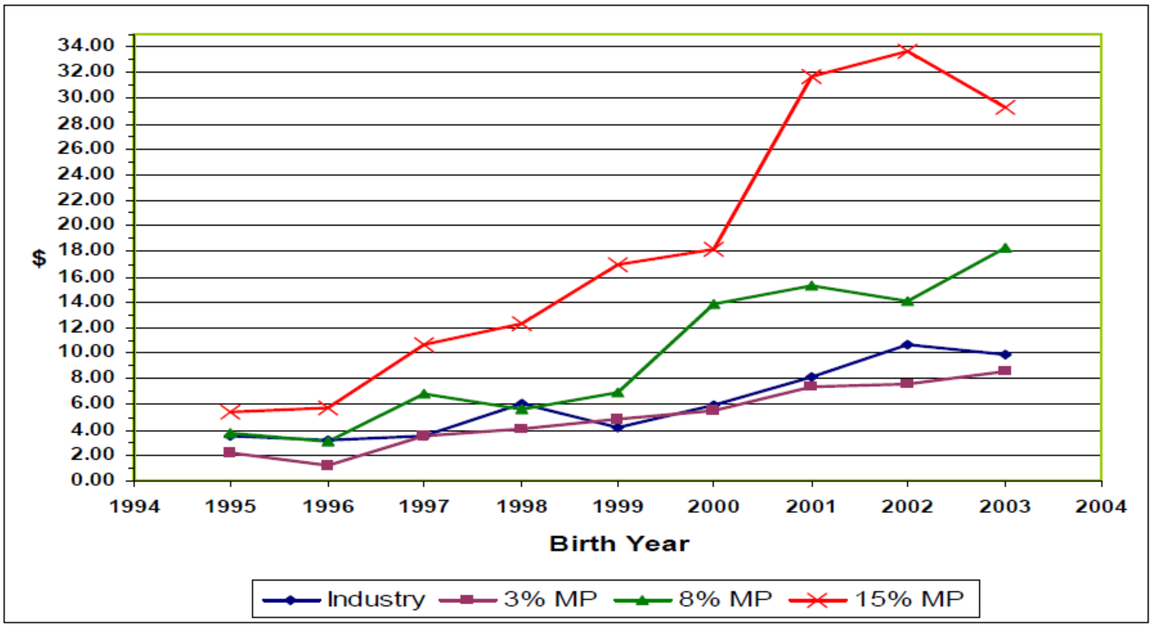


Figure 5 Increases in fleece value above controls in the high micron premium market



Number	29
Name	**Merino Superior Sires**
Traits researched	GFW, CFW, FD, FDSD, FDCV, CURV, CURVSD, SL, SS, Comf, CEM Meat - EMD, FAT (optional) WT WEC (Optional) All Visual Scores as included in Visual Sheep Scores Guide plus Classer's Grade
Date	2011
Target audience	Ram breeders and buyers
Target	Wool
Source	AMSEA, NSW DPI, AWI
Contact	Ben Swain, BCS Agribusiness Ph: 02 6743 2306 E: ben_swain@bigpond.com Advanced Breeding Services Ph 02 6391 3967 E: abs@industry.nsw.gov.au

Further Information

Permission	Yes
Summary of resources	Merino Superior Sires Publications 1-17 www.merinosuperiorsires.com.au (contains individual site reports)
File and format	**29a** (Merino Superior Sires) Merino Superior Sires 17 - 12 October 2011 (Full report).pdf **29b** Beyond the Bale Article BTB DEC 2011.pdf

Key Findings

- Merino Superior Sires offers genetic and visual comparisons between sires based on progeny performance at a site (Flock Breeding Values) and across site (Australian Sheep Breeding Values) level.
- Sires entered into sites that have ASBV information available show that breeding values are able to predict progeny performance.

Useful Information

- 10 independent sites evaluated sires through a progeny test adhering to industry agreed guidelines.
- *Merino Superior Sires* (MSS) is the publication of the combined site analysis (via MERINOSELECT).
- Each site also publishes a report based on results achieved at just that site.
- The program offers breeders a chance to observe genetic responses in different environments.
- The program has been running in Australia since 1987.

- It provides ram breeders and commercial woolgrowers with the ability to compare directly hundreds of sires that have been evaluated at independent sire evaluation sites.
- Sites are accredited through the governing body AMSEA (Australian Merino Sire Evaluation Association).
- Sheep are managed together under the same conditions throughout the period of the trial.
- Each individual site is linked (through the use of a sire that has been used at another site) to enable across-site and industry analysis.
- Sires are mated by AI to an equal allocation of ewes.
- Animals are assessed for a comprehensive list of wool, growth and visual traits.
- A report is generated at the site level in addition to the across-flock MSS. Site reports contain more detailed visual analysis observations.

Background

Merino Superior Sires (MSS) compares the breeding performance of a sire by the independent and comprehensive evaluation of his progeny. Progeny performance is expressed relative to the progeny of other MSS sires. MSS has been designed to assess a sire's breeding performance for a large number of traits important to breeders. This assists the selection of sires suitable to a large range of breeding objectives.

MSS sites are located across the majority of wool growing regions in Australia. All sires are mated to an equal allocation of ewes to ensure the difference between the progeny can be attributed to the sire and not the ewes. A minimum of 50 ewes from a classed and even line are mated to each sire with the aim of obtaining 25 or more progeny. 15-20 progeny can be expected to provide a satisfactory estimate of a sire's breeding value.

At least one "Link Sire" is mated for each 7 sires entered at a site. A Link Sire is a sire that has been mated previously at the site, or at another MSS site, and has 25 progeny which have been evaluated at least once.

Link sires act as the genetic connections between years and sites that allow the direct comparison of all the sires entered in MSS, regardless of when or where they are mated.

Site reports provide additional information on traits that are not presented in the combined analysis. Additional traits in site reports include individual conformation and wool quality traits, breech wrinkle scores and, for sites that consider them to be commercially important, internal parasite resistance and carcase traits. Site reports are available on the AMSEA website.

It should be noted that the MSS performance of an individual sire in isolation cannot be considered an indication of the performance of the stud which bred the sire.

Due to the use of AI and limited progeny numbers to assess reproduction, sire evaluation does not offer direct assessment of reproduction differences. A recent initiative will see one site collect fertility data.

Site Reports

Site reports provide an ideal way of demonstrating the performance of an individual sire in a particular environment and comparing that sire to others entered in the same trial.

The results published in Site Reports are Flock Breeding Values (FBVs) and are not comparable to the ASBVs reported in Merino Superior Sires, which compare sires across all sites, as well as other research and commercial flocks.

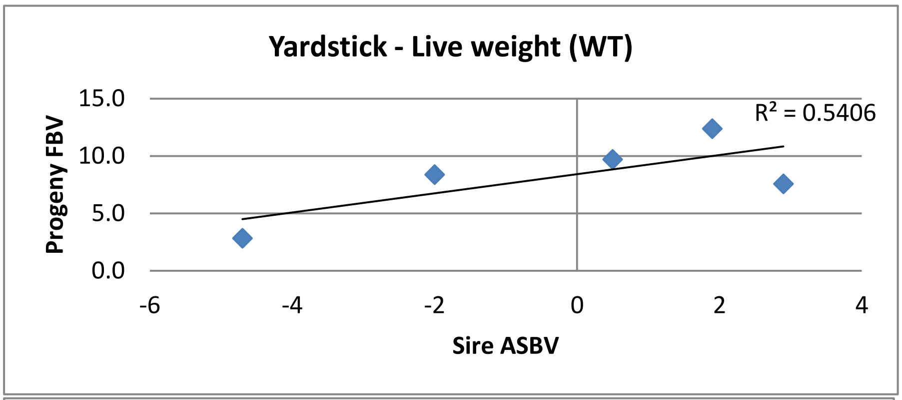
Site Reports provide detailed information on the visual performance of a sire’s progeny that is not published in Merino Superior Sires, nor is evident from ASBVs and Indices. Visual traits published in Site Reports, include:

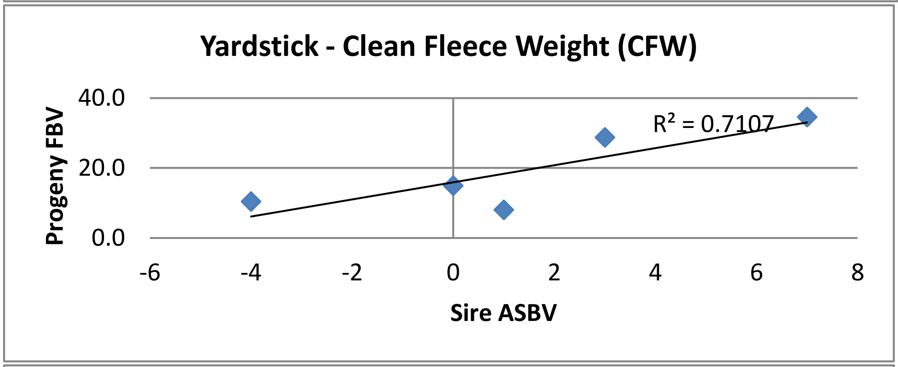
- Wool Quality traits including, Fleece Rot, Wool Colour, Wool Character, Dust Penetration, Staple Weathering and Staple Structure.
- Pigmentation traits including, Fibre Pigmentation, Non-fibre Pigmentation, Recessive Black, Random Spot.
- Confirmation traits including, Jaw, Feet and Legs, Shoulder/Back, Face Cover and Body Wrinkle.
- Breech traits including, Breech Cover, Crutch Cover, Breech Wrinkle and Dag.

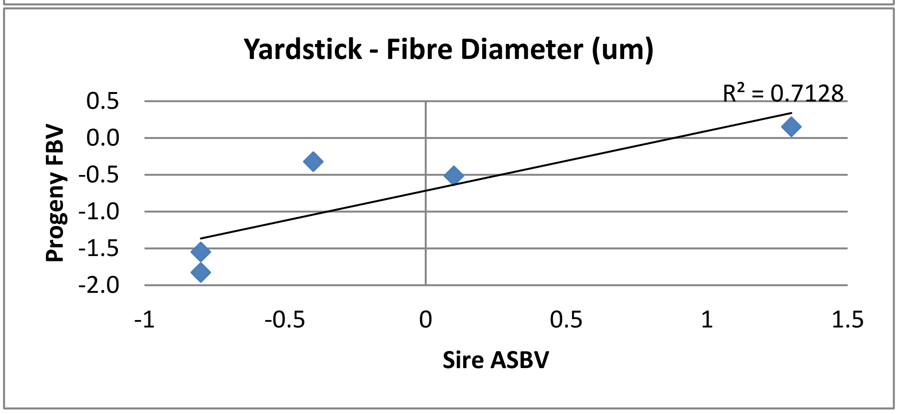
Site Reports include information in relation to the ewes that the sires were joined to and environmental conditions throughout the period of the trial.

Results

The following charts have been generated from the results from the Yardstick site using the 2010 drop progeny to highlight the value of breeding value information. The charts show sire ASBV values prior to progeny assessment compared to the performance of their progeny (Flock Breeding Values – FBV) at 15 months of age with 12 months of wool growth. Further results from this site are reported later in the document and a full site report is available from the Merino Superior Sires website (www.merinosuperiorsires.com.au). Five out of the 12 sires entered had ASBV performance available prior to joining.







Ref 29b Results from a sample site report (Yardstick WA 2010 drop) are presented below

	Within-flock Breeding Values (deviations)									Classer's Grade (deviations)		Indices	
Ram	**GFW %**	**CFW %**	**FD Um**	**WT kg**	**SL mm**	**SS N/ktex**	**Fat mm**	**EMD mm**	**WEC %**	**% of TOPS**	**% of CULLS**	**DP7%**	**Merino14% +SS**
Angenup, 7.640	-4	-2	-0.7	-6.2	-13.8	-0.4	-1.9	-2.3	176	-1	-6	68	99
Billandri Poll, 010564	3	3	0.1	-4.7	-1.5	4.4	0.3	0.9	-15	17	-7	102	106
Billandri Poll, 060904	3	0	-0.8	0.5	-1.5	-2.1	0.3	-0.1	74	-10	1	100	101
Challara, 070013	-2	2	0.8	-0.7	11.8	1.6	-0.1	-0.2	15	2	-2	97	100
Coromandel Poll, 08C053	2	1	-0.8	2.9	-8.3	-2.7	-0.7	-0.9	-29	2	-6	105	107
GRASS, 05-1615	-5	-4	-0.4	-2.0	-0.6	-4.3	0.3	+0.2	-59	-6	4	95	92
Merinotech WA Poll, 6533	6	7	1.3	1.9	7.8	9.6	0.3	1.8	-53	5	-11	125	111
Pinedale, 088124 (Dohne)	1	-1	0.5	11.1	-2.4	0.8	1.4	2.7	-50	-10	-11	141	101
Rolvenden, 246	-4	-5	0.5	-2.8	6.3	3.2	0.6	-0.1	-34	5	14	84	93
Thorthon Park Poll, 080274	-3	-6	-1.5	0.4	-3.8	-6.1	0.0	-0.3	26	-7	1	96	96
Wallinar, 08G186	6	9	0.5	-0.3	1.9	-0.2	-0.4	-1.1	61	10	3	99	105
Woodyarrup Poll, 080195	-3	-2	0.8	0.1	7.8	-1.9	0.3	0.2	10	-6	21	92	87
Average	**3.6**	**2.5**	**16.3**	**42.8**	**89.6**	**32.8**	**3.0**	**26**		**0**	**0**	**100**	**100**

Ram	Visual Trait Assessments (deviations)										
	Breech Wrinkle	Breech Cover	Dag	Body Wrinkle	Wool Colour	Fleece Rot	Wool Character	Staple Structure	Legs and Feet	Shoulder and Back	Non-fibre Pigmentation
Angenup, 7.640	0.5	0	1.2	0.1	-0.3	0.0	-0.2	-0.2	0.3	0.3	0.1
Billandri Poll, 010564	0.3	-0.1	0.0	0.5	-0.2	0.0	-0.4	-0.5	0.2	0.1	-0.1
Billandri Poll, 060904	0.2	0.1	-0.0	0.2	0.3	0.0	0.1	0.0	0.4	0.1	-0.1
Challara, 070013	-0.4	0	-1.0	-0.6	-0.4	0.0	-0.4	0.2	-0.2	-0.1	0.1
Coromandel Poll, 08C053	0.1	0.1	0.3	0.1	0.0	0.0	-0.2	-0.4	-0.1	0.1	-0.5
GRASS, 05-1615	-0.1	0.1	0.1	-0.1	0.3	0.1	0.3	0.3	0.0	-0.1	0.5
Merinotech WA Poll, 6533	0.0	0.2	0.4	0.1	-0.1	0.0	-0.2	0.0	-0.3	-0.2	-0.3
Pinedale, 088124 (Dohne)	-0.2	0	0.0	-0.3	0.4	0.0	0.3	0.0	-0.3	-0.2	-0.4
Rolvenden, 246	0.1	0.1	-1.0	0.1	0.2	0.0	0.2	0.1	0.2	0.0	0.6
Thorthon Park Poll, 080274	0.0	0	-0.0	0.3	0.2	0.1	0.1	-0.1	0.3	0.1	0.1
Wallinar, 08G186	0.1	-0.1	0.0	0.0	-0.3	0.0	-0.1	0.1	-0.3	0.0	-0.2
Woodyarrup Poll, 080195	-0.5	-0.4	-0.0	-0.4	-0.1	0.0	0.3	0.4	-0.3	-0.1	0.2
Average	**2.2**	**4.6**	**3.0**	**2.0**	**2.5**	**1.0**	**2.6**	**2.8**	**2.5**	**2.3**	**1.9**

Number	30
Name	**Rylington Merino Flock**
Traits researched	**WEC**, **Dags, faecal consistency**, GFW, FD, CV, SS, SL, YLD, carcase and fleece value
Date	1987 – continuing Productivity trial 2004
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool & Sustainable Worm Control
Source	DAFWA
Contact	Johan Greeff Ph: 08 9368 3624, John Karlsson Ph: 08 9851 1427

Further Information

Permission	Yes Farming Ahead articles have been reproduced with the permission of Kondinin Group and Farming Ahead.
Summary of resources	Farmnote Papers Farming Ahead article
File and format	**30a** fn_breeding_worm_resistant_sheep.pdf **30b** karlsson_wormresist.pdf **30c** Breeding_for_worm_resistance___whole_farm_benefits.pdf **30d** farming ahead article featuring rylington 2006.pdf **30f** GREEFF, J.C. and KARLSSON, L.J.E. 2006. Economic benefit of breeding for worm resistance. 8th *World Congress on Genetics Applied to Livestock Production*. Held in Belo Horizonte, Brazil from 14-18 August 2006. Brazil 2006 paper on economic benefits of worm resistance.pdf

Key Findings

- Drench resistance is making breeding for worm resistance a more important alternative for worm control.
- Selection for worm resistance using EBVs has economic benefits from the increase in productivity.
- WEC is heritable and has no antagonistic genetic correlations with other production traits.

- Selecting sheep for worm resistance results in cumulative gains.

Useful Information

- Research continues with the Rylington Merino flock which historically has used single trait within-flock selection for lower WEC but in more recent years has moved to across-flock and selection based on a 7%DP+WEC index.
- Selection line initiated in 1987.

Background

The Rylington Merino internal parasite resistant selection line was initiated in 1987 from a wide genetic base of 100 ewe flocks. Selection for parasite resistance was based on within-flock selection of animals with a low WEC in a natural parasite challenge environment (***ref 30b***).

Stage 1 of the project showed that by selecting for faecal worm egg count (WEC), a trait that is heritable in Merino sheep, it is possible to breed sheep for resistance to worms. An output of stage 1 was the development of the Rylington Merino resistant flock (co-operatively funded by the Wool Corporation from November 1987 until June 1994).

Stage 2 of the project found that selection for low WEC in the Rylington selection line did not result in any unfavourable changes in the three major production traits: body weight, clean fleece weight and fibre diameter (***ref 30c***). This stage of the project was necessary given it was highly unlikely that ram breeders would breed for worm resistance if doing so adversely affected other production traits.

Stage 3 of the project involved evaluating the whole farm benefit of having worm resistant sheep.

Results

Ref 30a

The realised annual genetic gain for the Estimated Breeding Value of WEC was 2.7% in this flock. The genetic gain in parasite resistance was achieved without any difficulty in managing adverse genetic correlations with other economically important production traits.

The following graph shows the genetic trend of the decline of the faecal WEC in the Rylington Merino selection line relative to that of the unselected control line. This graph represents a genetic gain of 2.7 per cent per year up to 2000 or about 10 per cent per generation for the selected line. This is very good considering that the annual genetic gain for most production traits in sheep is less than one per cent. During the main winter worm challenge period, the actual average faecal WEC output from hoggets in the two lines will vary from year to year due to seasonal variations in worm challenge.

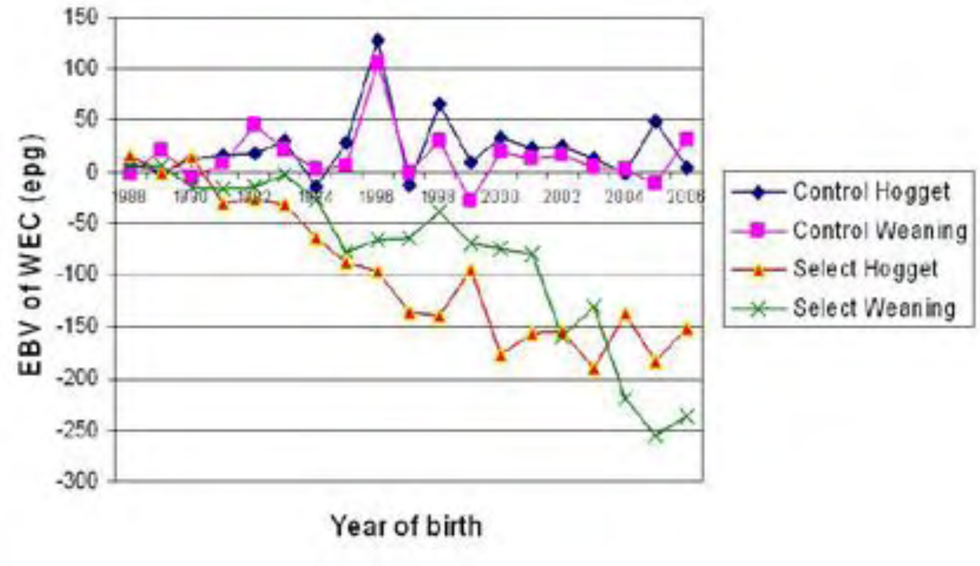


Figure 1 Genetic trend of Rylington Merino sheep selected for worm resistance compared to the unselected control group.

Ref 30f

A trial was conducted in 2004 at Mt Barker using ewes sourced from the Rylington Merino selection line and the Rylington control line. These were joined within their respective groups and then set stocked as the replicates from each line to allow for paddock differences in worm burden to be reflected in sheep performance. The progeny were then measured for an extensive range of production traits. The results demonstrate that selection for resistance has positive impacts on most production traits and improves both wool and carcase income.

Table 1. Differences in production traits between the resistant and control line.

Traits	Control	Resistant	Difference	P	SED
WEC weaning	1093	373	-720	<0.001	67
FS at weaning	2.26	2.46	0.2	0.04	0.09
WEC 14 mnths	52	35	-17	0.05	9
DS 14 mnths	1.16	0.35	-0.8	<0.001	0.13
FS 14 mnths	2.86	2.86	0.0	0.82	0.04
WWT (kg)	18.7	22.9	4.2	<0.001	0.55
BWT7 (kg)	22.5	25.5	3.0	<0.001	0.54
BWT9 (kg)	23.2	26.3	3.1	<0.001	0.48
BWT-shear (kg)	49.0	53.9	4.9	<0.001	0.87
CS at weaning	2.08	2.36	0.3	<0.001	0.05
CS7	2.23	2.37	0.1	0.03	0.06
CS9	2.14	2.56	0.4	<0.001	0.04
CS-shear	3.17	3.38	0.2	<0.001	0.04
FD (mic)	20.6	20.2	-0.4	<0.01	0.15
CV (%)	24.4	20.4	-4.0	<0.001	0.23
CUR (°/mm)	92.3	95.3	3.0	0.03	1.28
YLD (%)	70.4	71.6	1.2	<0.001	0.34
SL (mm)	96.0	97.0	1.0	0.37	1.1
SS (N/Ktex)	22.8	21.9	-0.9	0.28	0.77
GFW (kg)	3.7	3.9	0.1	0.03	0.06
CFW (kg)	2.6	2.8	0.2	<0.001	0.05

Table 2. Differences in income from wool and meat production between the resistant and control line.

$ Income from	Control	Resistant	Difference
Meat @ $1.20/kg live weight after shearing	$58.82	$64.68	$5.86
Wool	$18.07	$19.51	$1.43
Total income	$76.89	$84.18	$7.29

The income from the resistant group was 9.5% higher than that for the control group (Table 2). Results were based on the wool market of 2005 which was a low micron premium year.

Due to a low worm challenge in this year, no drenching was required. In a year when drenching is required income differences will be greater. The performance difference in favour of the selected worm resistant line is mainly due to a lower worm challenge in early life when young animals are most vulnerable.

Number	31
Name	**Selection Demonstration Flock**
Traits researched	FD, CFW, Index, Fleece $, Carcase $, All fleece traits, all carcase traits, all reproduction traits, all visual wool and conformation traits
Date	1996-2005
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	SARDI, AWI
Contact	Dr Forbes Brien 08 8303 7623 E: Forbes.Brien@sa.gov.au

Further Information

Permission	Yes Papers from the 8th World Congress on Genetics Applied to Livestock Production have been provided with full permission from the authors.
Summary of resources	Summary brochure Final newsletter Papers
File and format	**31a Summary Brochure** SDF__summary_brochure.pdf **31b Final newsletter** Brien, et al (2006) Merino Selection Demonstration Flocks Final Newsletter 10. **31c Paper** Kemper, K.E., Hebart, M.L, Brien, F.D. Jaensch, K.S., Smith, D.H. and Grimson, R.J. (2006) Genetic trends achieved under industry control for different selection strategies in Australian Merinos. *8th World Congress on Genetics Applied to Livestock Production*, Brazil. **31d Visual traits** Curnow, RA, Brien, FD, Pitchford, WS and Koopman, DJ. 2007. Response to selection method on visual traits in South Australian Merino sheep. *Proceedings of the Association for the Advancement of Animal Breeding and Genetics* 17: 107-110. **31e Visual traits presentation** Curnow visual trait presentation.pdf

Key Findings

- Different breeding methods impact on production and profitability, a system based on objective estimates of genetic performance achieved the highest dollar returns.
- Breeding values improve selection accuracy which enables faster rates of genetic gain.
- Breeding values can be combined with visual selection to produce superior outcomes.
- Selection incorporating an index returned the highest gross margins regardless of market conditions.
- The index based selection line saw some deterioration in eye muscle depth and, with the exception of the Elite selection lines, all flocks increased wrinkle.
- The index selection line had the best values for classer assessed wool style traits.

Background

In 1996, the Selection Demonstration Flock project was established to evaluate and demonstrate the strengths and weaknesses of the various selection strategies that are typically used in the Merino industry. The breeding methods applied to the flocks were named as Performance Index (Measured Performance Recording or MPR), Classer Assessed (Professional Classer Assessed or PCA) and Elite Wool (Elite Wool Flock or EWF).

The over-arching breeding objective was to maintain or slightly increase fleece weight and body weight. It was also decided that wool quality should be improved through reducing fibre diameter and fibre diameter CV, and improving style.

Exploring two new breeding directions embraced by industry, dual purpose Merinos and finer wool, a further two flocks were established in 2000 and 2001. The breeding objective of the Dual Purpose flock was to improve fleece and meat values using a combination of performance index and visual appraisal, while the breeding objective for the Fine Wool flock was to improve the profitability of fine wool sheep in a wheat/sheep environment by using a combination of visual and tactile assessment and objective measurement.

Useful Information

- Other than the fine wool flock, ewes were sourced from South Australian bloodlines with 200 allocated to each selection line.
- Outside sires were only used for the first two matings in the original flocks and the Fine Wool flock. The Dual Purpose flock continued to use outside sires.
- Initial advances for selection lines from the control in 1997 and 1998 progeny are attributed to introduced sires and foundation ewe screening. The impact of selection strategies is greatest during within-flock selection from 1999 to 2004 (8 years of selection).
- Genetic analysis to produce EBVs was a within-flock analysis.
- Industry management committees made the selection decisions.
- Skill level of committee members, changing opinions and small flock size, made the results at times difficult to interpret.

Results that support the use of ASBVs and measurement

The progressive outcome of each selection system was analysed by assessing progeny every year. In 2005, after 10 years of selection and breeding in the initial selection flocks and 5 years of breeding and selection in the newer flocks, the project concluded and the overall results were analysed.

The following is a list of findings from the project:

- The whole package (conformation, wool quality and measured performance) needs to be monitored along the way to ensure focus on target. Some negative performances in conformation and measured traits were observed in traits that were not directly targeted in the breeding objective.

- Flocks that did not utilise measurement in their selection system still benefited from the fact that measurement was used to evaluate their progress as part of the trial. Unfavourable trends in some traits were able to be identified and rectified, highlighting that measurement is critical for any selection system.
- The superiority of sheep selected at a young age is maintained through their lifetime.
- Breeding values improve selection accuracy which enables the Performance Index and the Dual Purpose flock to achieve more rapid genetic gain than the other flocks.

Trait progress/Genetic trends

Ref 31c:

Table 1. Selection line adjusted means for 2004 progeny hogget (16mo) mean fibre diameter (MFD), clean fleece weight (CFW), body weight (BWT) and staple strength (SS)

SELECTION LINE	MFD (μm)	CFW (kg)	BWT (kg)	SS (N/ktex)
Control	20.8[a]	3.55	47.1[a]	34.7
Measured Performance (MPR)	18.2[b]	3.72	48.4[ab]	33.3
Professional Classer (PCA)	19.1[cd]	3.71	49.6[b]	33.1
Elite Wool (EWF)	18.7[bd]	3.69	49.9[b]	37.1

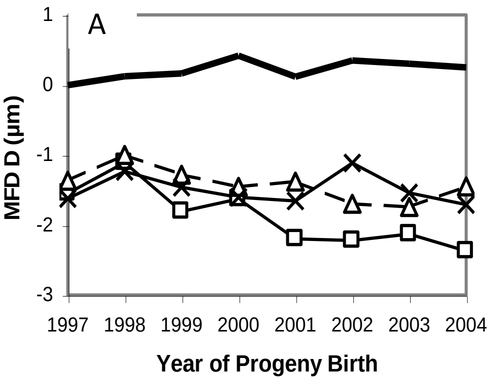
[a,b] Means with unlike superscripts differ significantly (P<0.05).

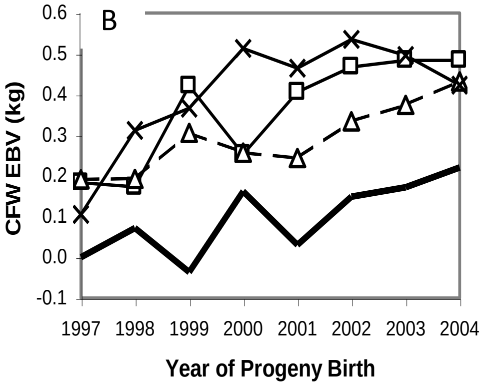
Mean fibre diameter genetic trend consistently declines for the Measured Performance flock, while no changes are evident for the professional classer or elite Wool flocks during within-flock selection (Figure 1A). The measured performance flock is finer than other selection lines and all selection lines are significantly finer than the control (P<0.05).

There was no significant difference between flocks for clean fleece weight (P<0.05) (Table 1). Despite randomised matings in the control flock, mean estimated breeding value for clean fleece weight has risen.

Body weight genetic trends mostly increase for the elite wool and professional classer flocks (Figure 1C). The measured performance flock shows large fluctuations but has recovered to control levels in 2004 progeny.

Staple strength genetic merit shows large variation initially and during within-flock selection (Figure 1D). Both the measured performance and professional classer flocks have unfavourable reductions and subsequent recoveries in staple strength.





C

D

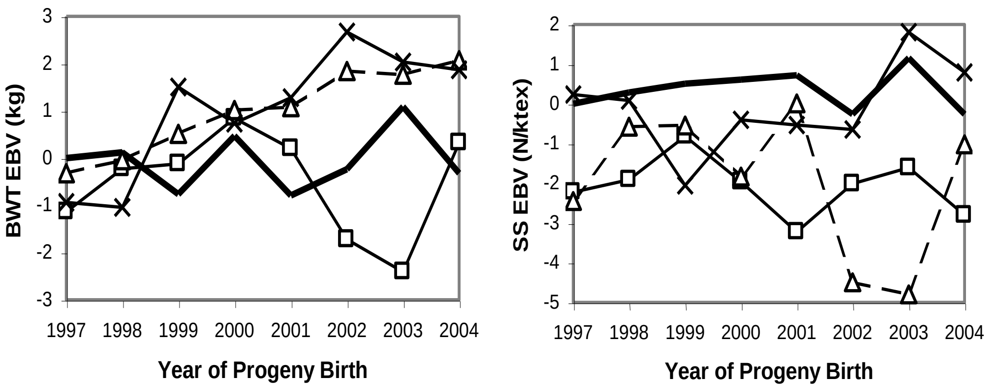


Figure 1. Mean estimated breeding value for measured performance (□), professional classer (Δ), elite wool (x) and control (–) progeny born into selection lines from 1997 to 2004 for hogget (16mo) *A*. mean fibre diameter (MFD, µm); *B.* clean fleece weight (CFW, kg); *C.* body weight (BWT, kg) and *D.* staple strength (SS, N/ktex)

Carcase traits - ref 31b (page 14)

Some small differences between the original flocks were observed in the analysis of the 2004 drop animals. With the exception of the dual purpose flock, early growth rates were very similar between selection lines with later growth rates slightly improved by the elite wool and professional classer selection lines. There was possibly a slight deterioration in eye muscle depth in the measured performance flock when compared to the control but it was not significantly different from the other original selection lines. The elite wool line appeared to have gained a little in fat.

Conformation/Visual trait results

There were few differences between selection lines for visually assessed wool and skin attributes. All flocks improved wool quality attributes although all flocks with the exception of the elite selection line increased both neck and body wrinkle. All flocks increased the number of tops and reduced the number of culls with no observed differences between flocks in structural performance.

Rate of genetic gain

The dual purpose flock continued to bring in outside sires based on reliable information. The rate of gain in this flock compared to other flocks was considerably higher. See the table below and page 39 of ***ref 31b*** - *SDF Newsletter 10.*

Where Fibre Meat + is the dual purpose flock.

Selection Line	**Rate of Genetic Gain Per Year**	
	Clean Fleece Weight (kg)	**Fibre Diameter (u)**
Fibre Meat+	0.11	-0.22
Measured Performance Recording	0.05	-0.15
Elite Wool Flock	0.04	-0.03
Professional Classer Assessment	0.03	-0.06

Financial analysis

It has been calculated that an additional $8 Million to $21 Million profit over 15 years could be made by South Australian wool producers if the performance-based sheep selection methods are used. This figure is based on extrapolating the results of the Benefit Cost study to the 4.9 Million head of Merino ewes in South Australia

ref 31b (page 64)

Table 1. Net Present Value ($ AUD/DSE) for an 'Owner Breeder' Structure

	PCA	EWF	MPR
Net Present Value	26.2	21.9	28.3
Benefit	27.5	23.3	29.9
Cost	1.3	1.3	1.6
Benefit Cost Ratio	21.3	17.3	18.3

Table 2. Net Present Value ($ AUD/DSE) for a 'Stud Breeder' Structure

	PCA	EWF	MPR
Net Present Value	25.6	21.3	27.6
Benefit	26.9	22.6	29.2
Cost	1.3	1.3	1.6
Benefit Cost Ratio	20.8	16.9	17.9

Ref 31a Summary Brochure

Measurement of each flock's progress was based on production data measured after 10 years of selection, within a typical self-replacing Merino flock enterprise to account for wool and carcase returns from adult sheep. Average fleece and carcase prices of the last 10 years and 5 years were used to develop Gross Margin values.

Gross margins of each flock: per adult shorn (GM/hd) and per hectare (GM/ha), based on 10 year and 5 year average prices

Flock	10 year $GM/hd	5 year $GM/hd	10 year $GM/ha	5 year $GM/ha
Control	25.40	21.40	144	114
Performance Index	33.10	35.00	196	211
Classer Assessed	29.30	27.80	166	155
Elite Wool	31.60	31.10	181	178

The 5 year average prices show a higher premium for fine wool and a higher carcase value than the 10 year average prices. Of these two effects, the higher premium for fine wool had the largest impact, particularly the premium below 19µ. The extra reduction in fibre diameter achieved by the Performance Index breeding method significantly increased the value of the wool from this group.

The Performance Index selection method returned the highest gross margins regardless of market conditions.

Additional fleece value information is referred to in ***ref 31b*** (page 19)

Dual Purpose Merinos (FM+) show superior carcase values

Using the 7%DP index - the dual purpose (FM+) flock produced progeny with the greatest carcase value under historic and more recent price scenarios. The higher carcase value is attributed to the faster growth rate in the FM+ (see ***ref 31b page 20*****).**

Table 16: Number of sheep in each carcase weight and fat score category and price in cents per kg. (2004 drop, both sexes)

Carcase weight range (kg)	Number of animals by Fat Score		2002 c/kg Fat score		2005 c/kg Fat score	
	1	2	1	2	1	2
Less than 18	440	124	180	200	200	200
18 to 20	79	86	230	250	250	260
20 to 24	77	112	240	260	280	290
Greater than 24	3	40	260	280	280	290

Table 17: Carcase value per head (10 month old sheep, 2004 drop, both sexes)

FLOCK	Number of animals	2002 Value/hd ($)	2005 Value/hd ($)
CON	220	38.72[a]	46.20[a]
MPR	154	37.78[a]	44.88[a]
PCA	184	39.52[a]	46.75[a]
EWF	211	39.08[a]	46.30[a]
FM+	192	47.51[b]	56.18[b]

Number	32
Name	**Breeding for Breech Strike Resistance Flocks**
Traits researched	Original ewes and progeny phenotype at several ages for: • Breech traits (wrinkle, wool cover, dag etc.) • Fleece traits • Body weight • Other disease traits • Incidence of strike
Date	2005 - ongoing in 2012
Target audience	Ram breeders and buyers
Target	Meat, Maternal and Wool
Source	CSIRO, DAFWA, AWI
Contact	CSIRO Jen Smith, Ph: 02 6776 1381 E: jen.smith@csiro.au DAFWA Johan Greeff, Ph: 08 9368 3624 E: jgreeff@agric.wa.gov.au

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	8 project newsletters 2 presentations (AWI website) Final reports Journal papers
File and format	**32a** Breeding_for_Breech_Strike_Resistance_Update_291110.pdf **32b** *Project newsletters* CSIRO DAFWA Project Newsletters 1-4.pdf **32c** (Sheep Genetics Website) http://www.sheepgenetics.org.au/MERINOSELECT/InformationItem.aspx?ITEM=124 **32d** MERINOSELECT wrinkle web 2.ppt **32e** *(Armidale Final Project Report (EC940))* EC940_finalreport_CSIRO_Nov2010_vFINAL_Apr2011.pdf **32f** *(DAFWA Final Project Report (EC940))*

	DAFWA Breech strike EC940 Final report to AWI combined version.pdf **32g** *(Paper - Breech Strike Indicator Traits – Brown)* Brown D. J., Swan A. A., Gill J. S. (2010) Within- and across-flock genetic relationships for breech flystrike resistance indicator traits. *Animal Production Science* **50**, 1060–1068. brown_swan_gill_aps.pdf **32h** *NSW DPI Primefact* Breeding-Merinos-for-less-breech-strike.pdf

Key Findings

- Two research flocks are undertaking a large scale project to develop a methodology for breeding for breech strike resistance. One site is in the summer rainfall environment of NSW and the other in the winter rainfall environment of WA. Results from these two sites are promising but suggest a slightly different strategy depending on genotype and rainfall dominance.
- In a summer rainfall environment with fine wool sheep, selecting animals based on wrinkle ASBVs will significantly reduce the incidence of breech fly strike (after an initial cull of any animal that may have been struck or was known to breed animals that were struck).
- In a winter dominant rainfall environment with medium wool sheep, dags are the most important indicator trait dominating the other indicator traits when present. Tail wrinkle is the next most important indicator trait followed by breech cover at hogget age.
- Indicator traits of dag, breech wrinkle, breech cover, urine stain and wool colour explain approximately 25% of the variation in breech strike (which is a similar percentage to what mulesing itself explains) more work is required to increase our understanding of natural resistance.

Useful Information

- Sires and replacement dams were chosen largely on breech-related traits, with little consideration of production characteristics.
- Attention was however paid to conformation characteristics.

Project aims

- To develop industry best practice guidelines for including breech strike resistance in Merino breeding programs.
- To evaluate the effect of selection using traits thought to indicate resistance to breech strike.
- To estimate the heritability of indicator traits, correlations between breech strike and indicator traits, and between indicator traits and production traits – enabling prediction of response to selection.

Background

- There are two sites: Armidale NSW and Mt Barker WA.
    - Armidale, NSW, fine wool, summer rainfall, half mulesed half not mulesed.
    - Mt Barker, WA, medium wool, winter rainfall, none mulesed from 2007.
- 3 original selection lines
    - Intense (selection on sires and dams).
    - Commercial (selection on sires only). This line was merged into the other lines at a later date.
    - Control (unselected).
- Ewe lambs sourced from selected industry flocks in 2005.
- First drop of lambs 2005.
- Industry AI sires, link sires across years.
- Original ewes and progeny phenotyped at several ages for:
    - Breech traits (wrinkle, wool cover, dag etc.)
    - Fleece traits
    - Body weight

    - Other disease traits
- No chemical prevention, high surveillance of animals.
- Full pedigree recording.
- Monitoring fly population, climate data.

Armidale Selection Process

- During the initial project, the primary selection criterion was breech cover, followed by crutch cover and breech wrinkle. Production traits were only considered after the breech traits and preference was given to finer wool types. Initially selections were based on phenotype, but ASBVs for breech traits were used as they became available.
- It became apparent that in finewool sheep in the summer rainfall environment, breech wrinkle, rather than breech cover, is a far better candidate selection criterion for breech flystrike.
- In finewool sheep, breech cover has lower variance, lower heritability, and lower correlation with flystrike itself than breech wrinkle. Breech cover is also not correlated with breech wrinkle.
- Breech strike and breech wrinkle are now the primary selection criteria in the Armidale flock, but some attention is still paid to breech cover and crutch cover, and dag, along with production traits.

Mt Barker Selection Process

- Originally three lines of ewes were established. A resistant line (A) in which initial selection was based on known indicator traits: dags, wrinkles, breech cover and the ability to resist being struck. Two random lines were also selected from participating flocks. One of these lines (B) was used as a randomised or unselected control and the other represented a commercial production scenario, line (C). Rams from the resistant line (A) were used to mate with ewes in line (C).
- Rams for the resistant line (A) were identified on the basis of information on breech strike or known indicator traits for breech strike. Control lines were selected randomly from the Katanning resource flocks.
- It became clear that there were larger differences in breech strike between sires within lines than between lines and the emphasis shifted towards differences between sire groups.
- As strike and production data became available, sires were selected on the resistance level against breech strike in following an independent culling protocol for ram using a 7% dual purpose index.

Results

- Genetic parameters arising from the project have been used to estimate the heritability of breech strike and identify key indicator traits that could be used to select indirectly for breech strike.
- This information was used to develop ASBVs for wrinkle, dag and breech cover.

Results - Armidale- fine wool sheep

- After 2 generations, there were consistent differences between selected and control lines with indicator traits and breech strike.
- Results suggest selective breeding for breech strike resistance is an achievable means of breech flystrike control.
- In the Armidale temperate, high summer rainfall environment:
    - Breech wrinkle was the trait identified as being most useful as an indirect selection criterion.
    - Breech wrinkle was variable, heritable and correlated with breech strike.
    - Dag was correlated with breech strike, but had lower scores, variability and heritability, making that trait less effective and less important when breech wrinkle is still high as a potential selection criterion.
    - Use of the other indicator traits in this study, including breech cover and crutch cover, as additional selection criteria did not provide any further advantage over and above breech wrinkle and dag.
- 2011 drop progeny at Armidale are the result of selecting sires using breech wrinkle ASBVs as a means to improve fly strike resistance.

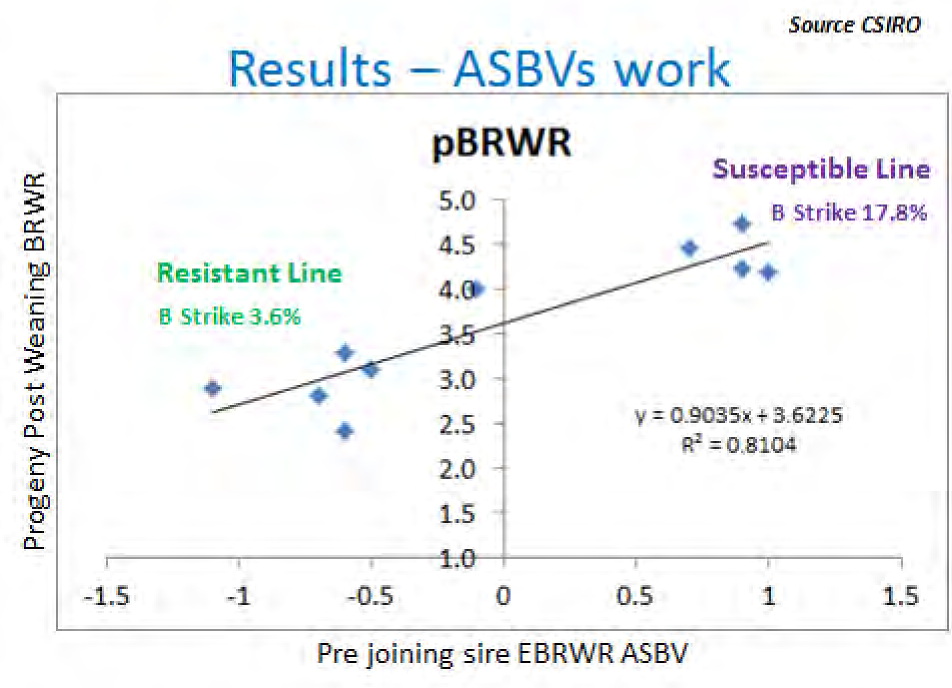
- The table below shows the phenotypic outcomes as a result of using the sires with lower breech wrinkle ASBVs over highly selected ewes (source Dr J Smith, pers comm). Both the sire and ewe ASBVs pre joining are provided compared with resulting progeny performance.

	Progeny no	Sire ASBV		2011 Progeny Phenotpye				
		EBRWR	EBCOV	mBRWR	mBCOV	wBRSTR#	pBRWR	pBCOV
Resistant	***dam***	***-0.5***	***-0.1***					
1	48	-0.7	0.1	2.0	4.5	2.0	2.8	4.4
2	38	-0.6	0.5	2.6	4.5	5.0	3.3	4.7
3	36	-0.6	0.3	2.1	4.7	3.0	2.4	4.7
4	37	-1.1	0	2.1	4.5	3.0	2.9	4.4
5	40	-0.5	0.3	2.0	4.6	5.0	3.1	4.7
Average		**-0.7**	**0.2**	**2.2**	**4.6**	**3.6**	**2.9**	**4.6**
Susceptible	***dam***	***0.4***	***0.0***					
1	28	-0.1	0.1	3.4	4.8	0.0	4.0	4.8
2	27	0.9	-0.3	3.2	4.6	15.0	4.2	4.6
3	23	0.9	-0.2	3.8	4.7	30.0	4.7	4.8
4	32	1	-0.4	3.3	4.8	22.0	4.2	4.8
5	36	0.7	0.1	3.4	4.8	22.0	4.5	4.7
Average		**0.7**	**-0.1**	**3.4**	**4.7**	**17.8**	**4.3**	**4.7**

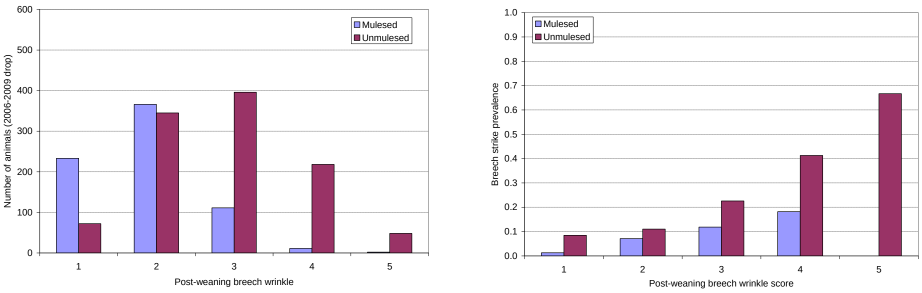
6 sires from within the flock and 4 external with links to industry

weaner breech strike (%) under challenge conditions (no preventative chemical treatment) in period from early Nov 2011 to 12 January 2012.

"m" refers to marking, "p" to post weaning. E refers to early.

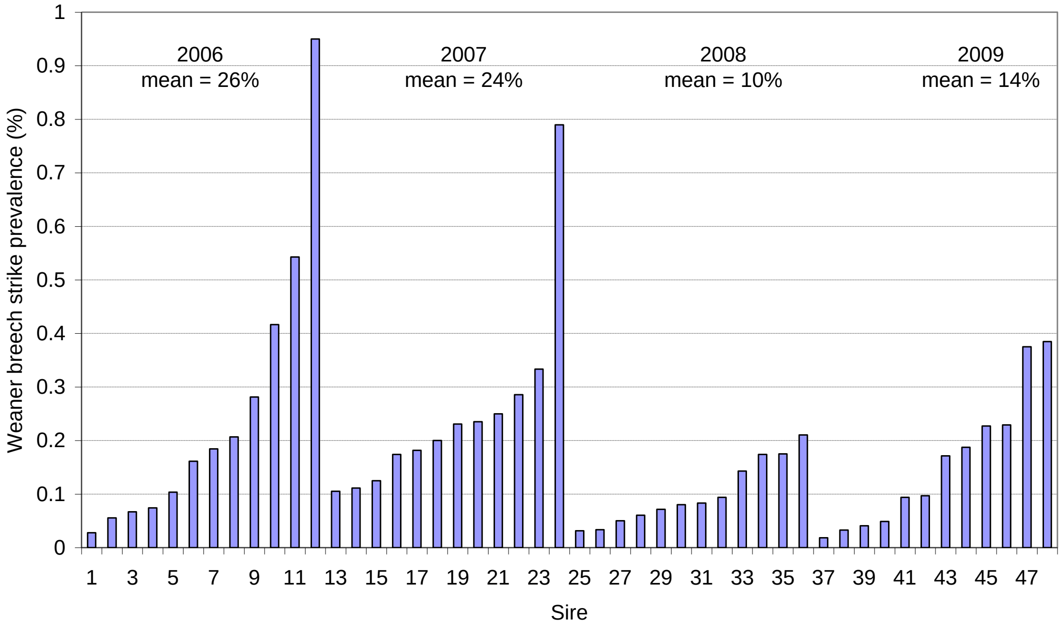


Ref 32b



Frequency distribution of breech wrinkle in Armidale research flock (left); breech flystrike rate at different breech wrinkle scores (right).

There is a wide variation between sires for breech strike prevalence – which means there is good potential for change in breech strike rates through selection of the right sires.



Results – Mt Barker - WA-medium wool sheep

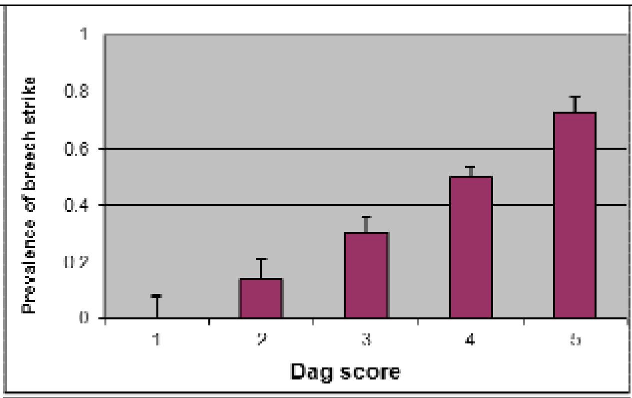
Ref 32f

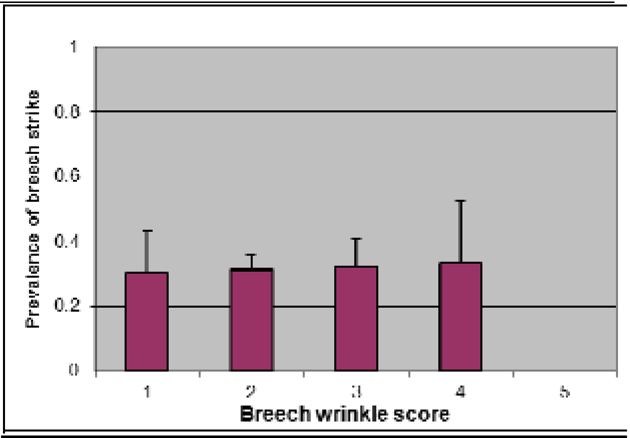
- Large differences were detected between sire progeny groups in breech strike resistance.
- Only 2.5% and 8.9% of the most resistant sires' progeny were struck compared to 94% and 103% for the two most susceptible sires.
- Indicator traits of dag, breech wrinkle, breech cover, urine stain and wool colour explain approximately 25% of the variation in breech strike.
- The presence of dags was the most important indicator trait in a winter rainfall environment and dominated the other indicator traits when present.
- Tail wrinkle was the next most important indicator trait followed by breech cover but only at hogget age.
- 81 sires were progeny tested for breech strike resistance from 2006 to 2010.

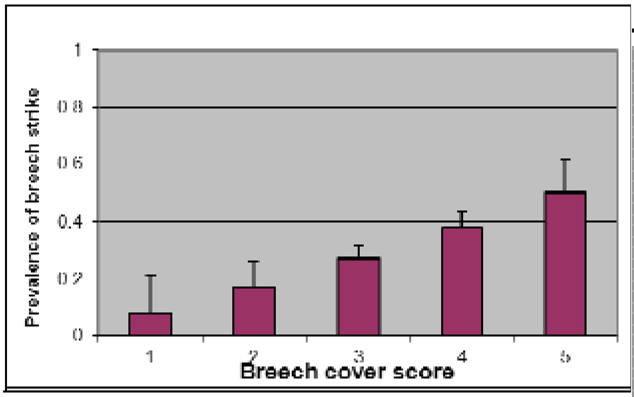
Ref 32b

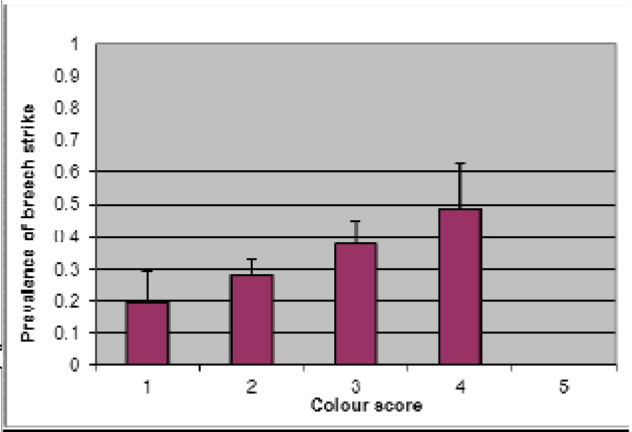
The following graphs from DAFWA Newsletter Issue 4 show the prevalence of breech strike with indicator traits. Unlike the Armidale results there is no relationship between strike and breech wrinkle. This occurred because the presence of dags completely overrides the importance of breech wrinkles and urine stain. It should also be noted that the research flock is plain with very few animals greater than visual wrinkle score 2.5.

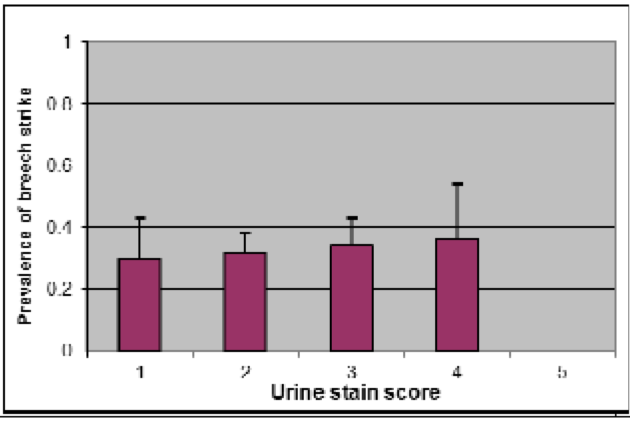
Breech wrinkle remains important despite the strong relationship between dags and strike. There is a complex set of interactions that exist between breech wrinkles, dags and breech cover. As the combined score from these individual traits increases, there is an increased incidence of breech strike but at different stages. The focus needs to be on reducing the average score of these three indicator traits in all flocks.









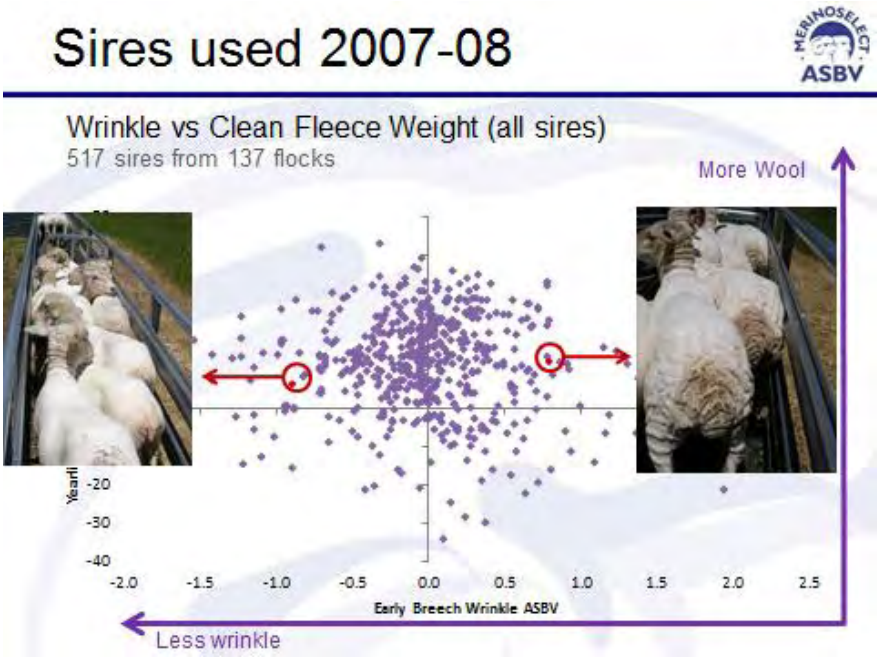


Correlation of indicator traits with other production traits

- Reducing expression indicator traits may be of economic value separate from breech strike.
- Reduced dags lead to reduced crutching costs and wool losses.
- High breech wrinkle leads to reduced fertility, increased lamb mortality, increased shearing time.
- Low breech wrinkle is positively correlated with lower fleece weights.

Despite the negative relationship between lowering wrinkle and increasing fleece weight, like many other correlations, such as that between fibre diameter and fleece weight, it is possible to reduce breech wrinkle yet increase fleece weight.

Ref 32d



Ref 32b

Production comparison between more resistant and less resistant

There is no significant relationship between strike resistance and either CV of fibre diameter or curvature. There are significant relationships between strike resistance and fleece weight, fibre diameter and hogget body weight. The more susceptible animals cut 100g less wool that was 0.1 micron finer, and they weigh 4.5kg more at hogget age.

Genetic analysis and modelling beyond the Breeding for Bare Breech Project

Ref 32g – Brown et al (2010)

Key Findings

- Breech strike indicator traits are all heritable but there are antagonisms between breech wrinkle and some production traits, primarily fleece weight and fibre diameter.
- Selection based on an index is required to counter the negative correlations.
- Modelling suggests that the use of both across- and within-flock selection for breech wrinkle and productivity will lead to considerably faster genetic gains than reliance on within-flock selection only.
- Sheep Genetics released early breech wrinkle ASBVs in September 2009 to assist Merino breeders make faster progress towards reducing breech wrinkle.
- Including selection for breech wrinkle in breeding objectives will impact on the progress of other production traits.

Background

The industry is currently implementing selection strategies for flystrike resistance to reduce the need for breech flystrike prevention. The following indicator traits are used to select for breech flystrike resistance: wool cover, skin wrinkle on the body and breech, scouring (dags) and wool colour.

The aims of this study were to estimate genetic correlations between these indicator traits and production traits using the Sheep Genetics database, to distinguish between within and across-flock genetic relationships, and to quantify responses to selection using indices that include breech wrinkle as a proxy trait for flystrike resistance.

Breech flystrike indicator traits are all heritable but there are significant antagonisms between breech wrinkle score and some production traits, primarily fleece weight and fibre diameter. Thus, simultaneous improvement in both flystrike resistance and production will be most efficient when index selection is used.

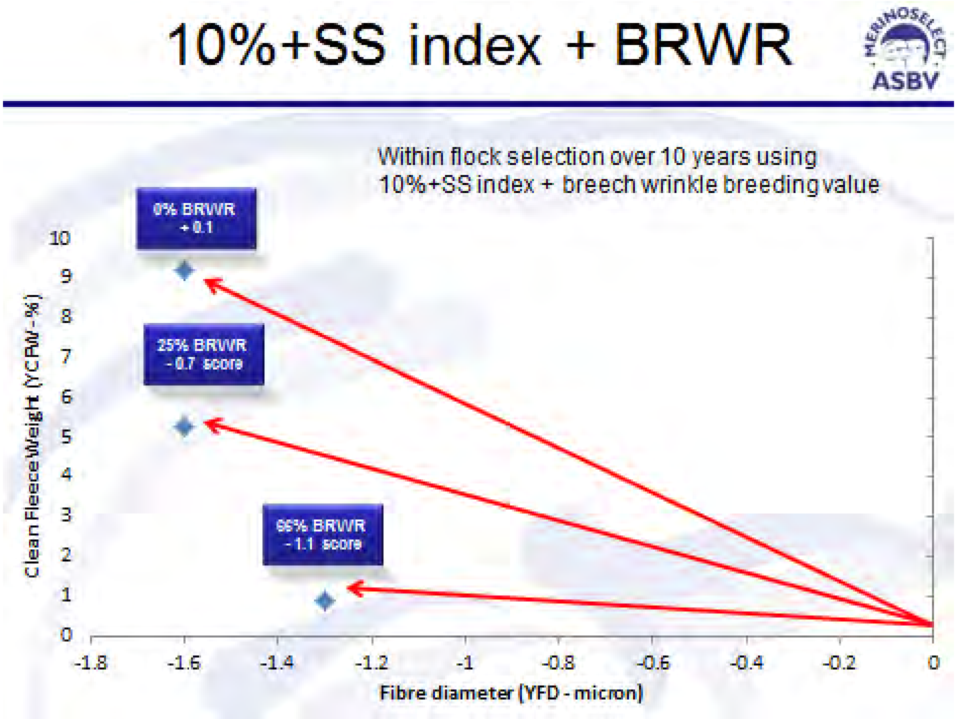
Our results show that, depending on the level of emphasis placed on breech wrinkle in the index, reductions in breech wrinkle score of 0.4–0.9 units can be achieved over a 10-year period. As across-flock relationships are generally stronger than within-flock relationships, breeders will be able to take advantage of this additional variation, depending on the relative merit of their flocks. Therefore, ram breeders should combine within-flock selection with across-flock selection where possible. Sheep Genetics released early breech wrinkle Australian Sheep Breeding Values in September 2009 to assist Merino breeders in making faster progress towards reducing breech wrinkle by using flock selection.

Results

Table 8. Ten-year predicted responses to selection using F10SS indexes inclusive or exclusive of breech wrinkle score
acfw, adult clean fleece weight; adcv, adult fibre diameter coefficient of variation; afd, adult fibre diameter; awt, adult bodyweight; bwr, breech wrinkle; nlw, number of lambs weaned; ycfw, yearling clean fleece weight; ydcv, yearling fibre diameter coefficient of variation; yfd, yearling fibre diameter; yss, yearling staple strength; ywt, yearling bodyweight. Across-flock parameters are those estimated from this study while the within-flock parameters are average estimates from research flocks

Trait	Units	Across-flock parameters				Within-flock parameters			
		F10SS	+25%	+50%	+66%	F10SS	+25%	+50%	+66%
ycfw	%	9.2	8.2	7.0	6.1	9.2	5.3	2.6	0.9
yfd	µm	−1.6	−1.1	−0.7	−0.5	−1.6	−1.6	−1.4	−1.3
ydcv	%	−0.4	−1.2	−1.3	−1.4	−0.4	−0.8	−0.9	−0.9
ywt	kg	2.9	4.2	4.2	4.0	2.9	3.8	3.9	3.8
acfw	%	4.6	3.4	2.6	2.0	4.6	1.4	−0.5	−1.7
afd	µm	−1.6	−0.9	−0.6	−0.3	−1.6	−1.6	−1.4	−1.3
adcv	%	−0.5	−1.2	−1.3	−1.4	−0.5	−0.9	−1.0	−1.0
awt	kg	1.7	3.0	3.2	3.2	1.7	2.8	3.2	3.3
nlb	%	3.0	3.0	3.0	2.0	3.0	3.0	3.0	3.0
yss	NKtex	2.0	1.8	1.6	1.3	2.0	1.3	0.8	0.4
bwr	1–5 score	0.7	−0.4	−0.7	−0.9	0.1	−0.7	−0.9	−1.1

Based on Brown et al (2010) work but reported in ***ref 32d***.



Number	33
Name	**Merino Bloodline Performance Package**
Traits researched	CFW, FD, CV, GM/DSE, YLD, WT, Style, SL, Colour, tender (extensive wool measurements),
Date	July 2010
Target audience	Ram breeders and buyers
Target	Wool
Source	NSW DPI, AWI
Contact	Sally Martin M: 0400 782 477 E: sallymartin777@gmail.com Advanced Breeding Services Ph: 02 6391 3967 E: abs@industry.nsw.gov.au

Further Information

Permission	Yes
Summary of resources	Wether trial guidelines Merino Bloodline Package • 2010 analysis • 2007 analysis • 2005 analysis
File and format	**33a** (*Running a wether trial)* guidelines_comparisons_2005.pdf **33b** Merino-bloodlines-the-comparisons-1999-2010.pdf

Key Findings

- Wether trials are commercial genetic benchmarking tools: randomly selected teams of wethers from each participant are run together and their performance is measured.
- Bloodline comparisons involve collation of wether trial results from across Australia in which each bloodline is represented by several teams. Merino Bloodline Performance is the combined analysis of individually run wether trials that have common bloodline links between sites. Teams representing a bloodline that participate in more than one wether trial form the links.
- The bloodline comparisons and wether trials highlight the huge range in genetic variation that exists and translates into opportunities for the Merino industry. Collectively, they also act as a signpost for breeders who use MERINOSELECT to exploit these opportunities.

Note

- Ewe trials, wether trials and sheep productivity trials emphasise a large variation in the genetic performance between animals. Superior performance in these trials is at times attributed to the

incorporation of advanced genetic technologies like breeding values and indexes or the inclusion of objective measurement in selection programs. They also stress the need to use tools that describe genetic differences when making ram and sire choices

Useful Information

- Bloodline package 1999-2010:
  - Combined analysis of 57 wether and ewe trials representing 145 bloodlines.
  - Wether trials run for a minimum of two years, and an average of three years.
  - Wether trial teams must be selected according to the guidelines set out in Designing and conducting Merino wether comparisons and on-farm genetic evaluations (***ref 13a***).
  - Outlines an easy five step process to determine whether there is benefit in changing ram source and helps to identify alternative sources.
  - 11 individual traits as well traits combined into two gross income values.
  - Gross income is calculated using a five year average wool price from 2005/2006 to 2009/2010 (adjusted for other wool characteristics such as staple strength, style and colour) and a carcase value based on average mutton prices over the same period. One fleece and 0.4 carcase value (2.5:1) are combined to make up the gross income. Bloodline liveweight is used to calculate a DSE rating to account for differences in potential stocking rate.

Background

Wether trials have been an important source of genetic comparison for the Merino industry for over 30 years. A wether trial run adhering to the guidelines enables growers to determine how their flock compares genetically with other flocks in the comparison. Individual comparisons are extremely valuable although do come with some limitations. To overcome some of these constraints, results from individual sites are combined into an across-site/trial analysis and published as the Merino Bloodline Package.

A wether trial is an evaluation whereby a commercial producer's team comprises a number of wethers that have been randomly selected. They are taken to a site where they are run together for a minimum of 2 years in one management group. At each shearing, fleece performance is assessed and a dollar value established. At the conclusion of the trial, total fleece value and carcase values are combined to provide an overall return.

Advantages of wether trials are that they offer a relatively simple mechanism for commercial flocks to benchmark their genetic performance. They allow an easy and cost effective assessment of the economically important traits (with the exception of reproduction) and raise awareness of flock performance compared to others.

Wether trials have limitations. Usually there is a limited range of other bloodlines in the comparison and the standard of the rams purchased from the stud will have an influence on their performance. If a trial doesn't include any high performance local bloodlines, participants may gain a false idea of the industry standard. Further, reproduction rates cannot be compared in these comparisons.

To add value to the many wether trials conducted around Australia, a combined analysis is performed every 2 to 3 years and is published as the Merino Bloodline Package. The package, funded by AWI in conjunction with the NSW Department of Primary Industries, combines the results from wether trials and on-farm comparisons run across Australia over the previous 10 years. The combination of individual trials enables comparison of bloodline performance rather than individual flock performance.

The Merino Bloodline Package highlights wool production, wool quality and profitability of bloodlines and allows woolgrowers to compare the relative strengths and weaknesses of each bloodline. The analysis takes out all environmental factors between trials and years, leaving only the genetic variation between the bloodlines. The combined analysis also has constraints:

- the analysis is unable to account for the difference in the standard of sires representing a bloodline which are used by entrants.
- the analysis is unable to account for the number of entrants representing each bloodline.

- reproduction cannot to be considered.
- bloodline performance is historic, reflecting genetic performance that ranges back over a 10 year period.

Results

1999-2010 bloodline performance results lists 145 individual high and medium accuracy bloodlines for production traits, components of wool type and gross income performance.

Range in bloodline performance in the 1999 to 2010 analysis:

Trait	Min	Max
Clean Fleece Weight (4.3kg)	-12.2%	5.6%
Fibre Diameter (20um)	-11.9um	1.0um
Live weight (ave 51.5kg)	-8.6%	8.4%
Gross income (ave $51.78)	-9.5%	15.8%

Ref 33b

Figure 1 Trend for clean fleece weight relative to fibre diameter – 268 Merino bloodlines

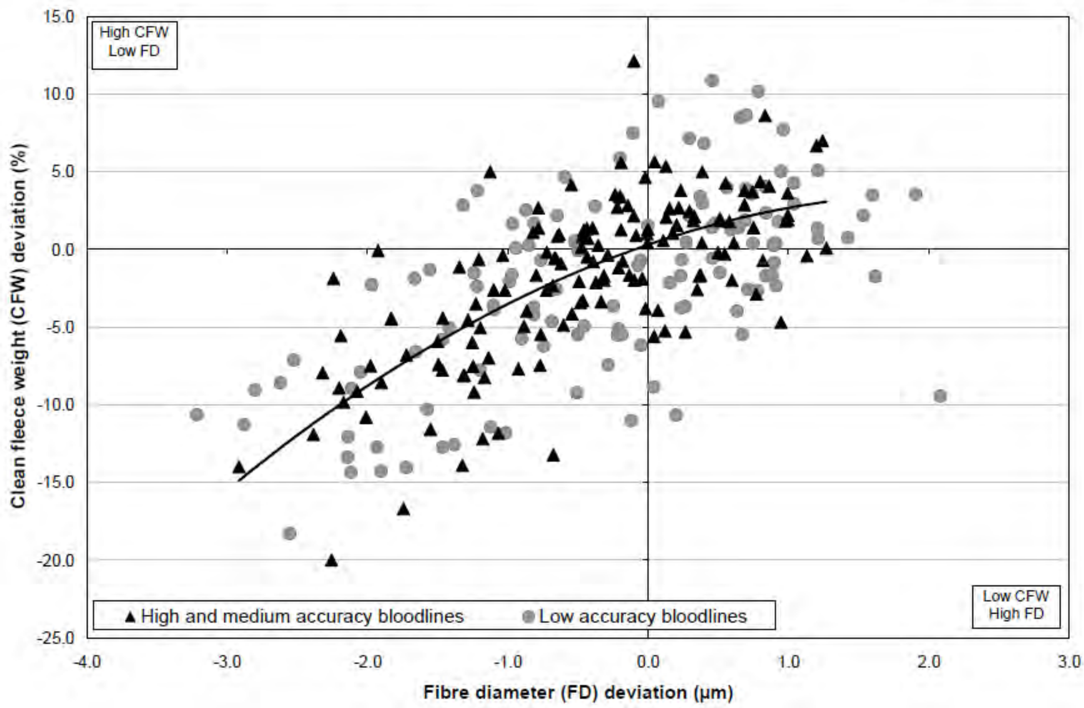


Figure 2a Bloodline deviations for clean fleece weight (CFW) and fibre diameter (FD) for the 53 high accuracy bloodlines

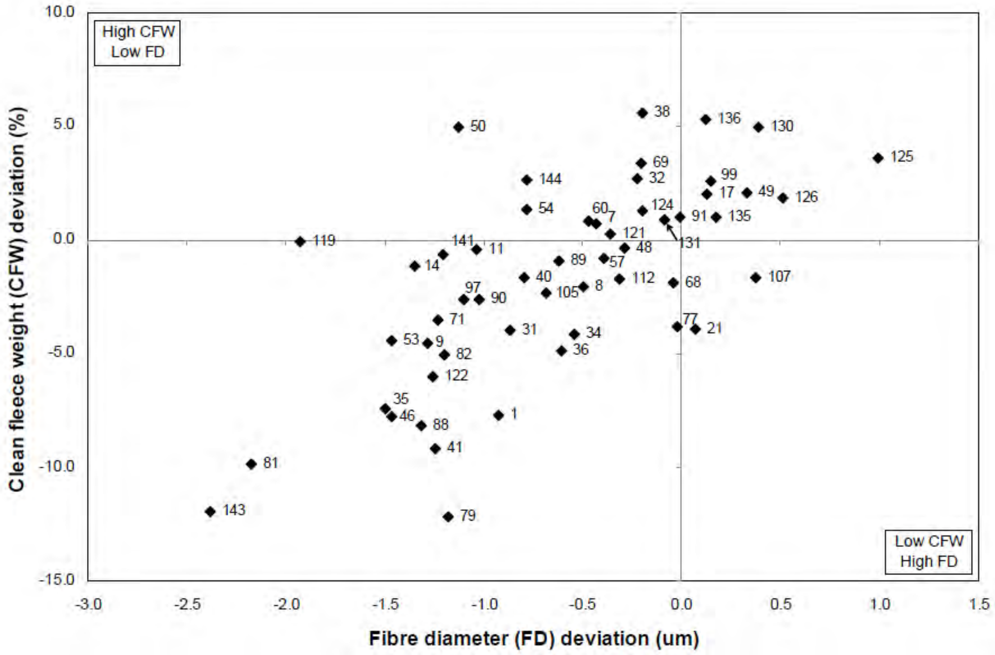
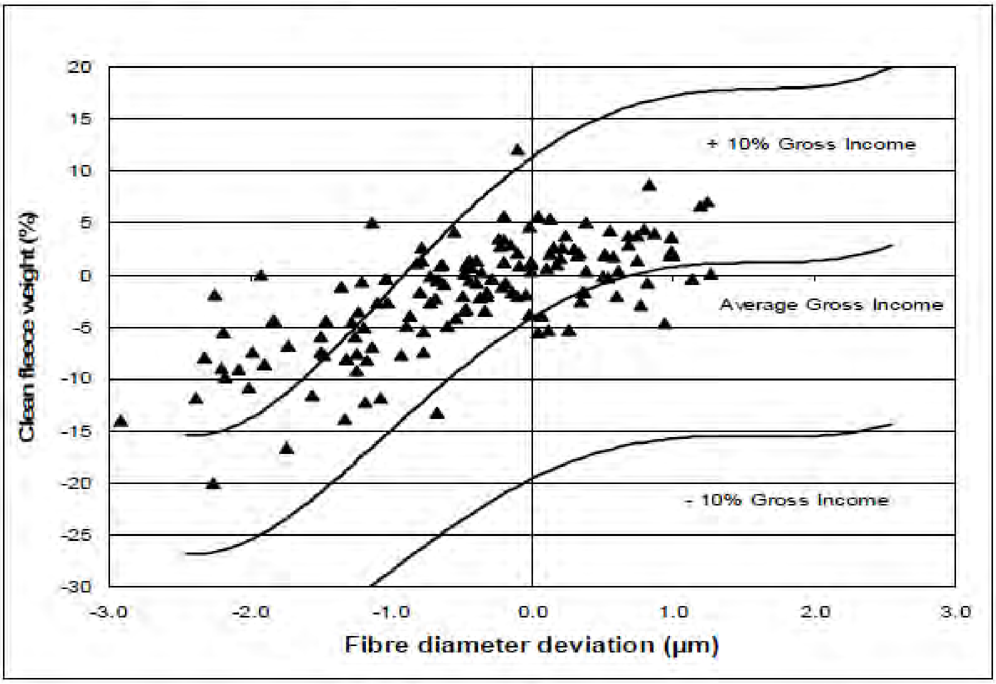


Figure 5 Micron premium contour graph



Number	34
Name	**Peter Westblade Memorial Challenge 2010-2012**
Traits researched	FD, CV, SD, Comf, Yld, GFW, SL, SS, Colour, Fat Score, Body Wrinkle, Fleece rot, Wt (7 in total), Carcase Wt, Dressing percentage; EMD; EMW; EMA; FatC; FatGR; Meat pH; Meat Colour; Carcase length.
Date	April 2010
Target audience	Ram breeders and buyers
Target	Wool and Meat
Source	Sally Martin
Contact	Sally Martin M: 0400 782 477 E: sallymartin777@gmail.com

Further Information

Permission	Need to acknowledge Sally Martin, Craig Wilson Livestock, DPI and Moses and Son. Farming Ahead articles have been reproduced with the permission of Kondinin Group and Farming Ahead. Please cite the journal source when using in future publications.
Summary of resources	Farming ahead article Power point presentation
File and format	**34a** *Kondinin paper* Farming ahead, October 2011, No 237, www.kondiningroup.com.au **34b** *Powerpoint* Martin Presentation_Wether trial_PWMMC.pdf **34c** *posters* pwmmc combined poster file.pdf **34d** *AAABG Poster* Martin, S.J. Wilson C.A., Moses, M.J. van de Ven, R. and Hopkins, D.L. (2011) VARIATION IN MERINO WETHERS FOR GROWTH AND CARCASE TRAITS. *Proc. Assoc. Advmt. Anim. Breed. Genet. 19:poster* martin474.pdf **34e** *Final report to MLA* pwmmc mla final report.pdf

Key Findings

- There is huge variation in performance within a flock and across flocks and this creates tremendous opportunity.

- In the Peter Westblade Memorial Merino Challenge, performance testing and genetically evaluating bloodlines dominated the single largest evaluation of commercial Merino genetics.

Note

- Ewe trials, wether trials and sheep productivity trials emphasise a large variation in the genetic performance between animals. Superior performance in these trials is at times attributed to the incorporation of advanced genetic technologies like breeding values and indexes or the inclusion of objective measurement in selection programs. They also stress the need to use tools that describe genetic differences when making ram and sire choices.

Background

The Peter Westblade Memorial Merino Challenge (PWMMC) is a successful collaboration between Industry & Investment NSW and private industry itself. The PWMMC is based on the evaluation of 50 wether teams from across Australia and has successfully integrated finishing and key carcase and meat quality traits into the standard Merino wether trial protocol. Early results from the PWMMC have demonstrated that Merino wethers have sufficiently fast growth rates and their carcases meet market specifications in terms of carcase weight and fat score at slaughter when fed intensively. Furthermore, analysis of various meat quality parameters indicates that meat from Merino wethers can attain acceptable levels for traits like colour and pH.

Useful Information:

- 1500 sheep, comprising 50 teams of 30 wethers from around Australia.
- 45 teams were from NSW, 4 from Vic and 1 from Western Australia.
- Half the animals were randomly allocated to the Wool Challenge, half to the Meat Challenge.
- The Meat Challenge was conducted at Collingullie NSW where the animals were run on pasture for 4 weeks on irrigation then put into feedlot.
- The Wool Challenge was run at Temora Agricultural Research and Advisory Station as a commercial wether trial to assess wool traits.
- Wool Challenge had 2 assessment shearings in April 2011 and March 2012.
- March/April 2011 wool and mutton prices are those reported in the Wool Challenge report.
- Spot market 31/3/11 v's 5 year average prices

Results

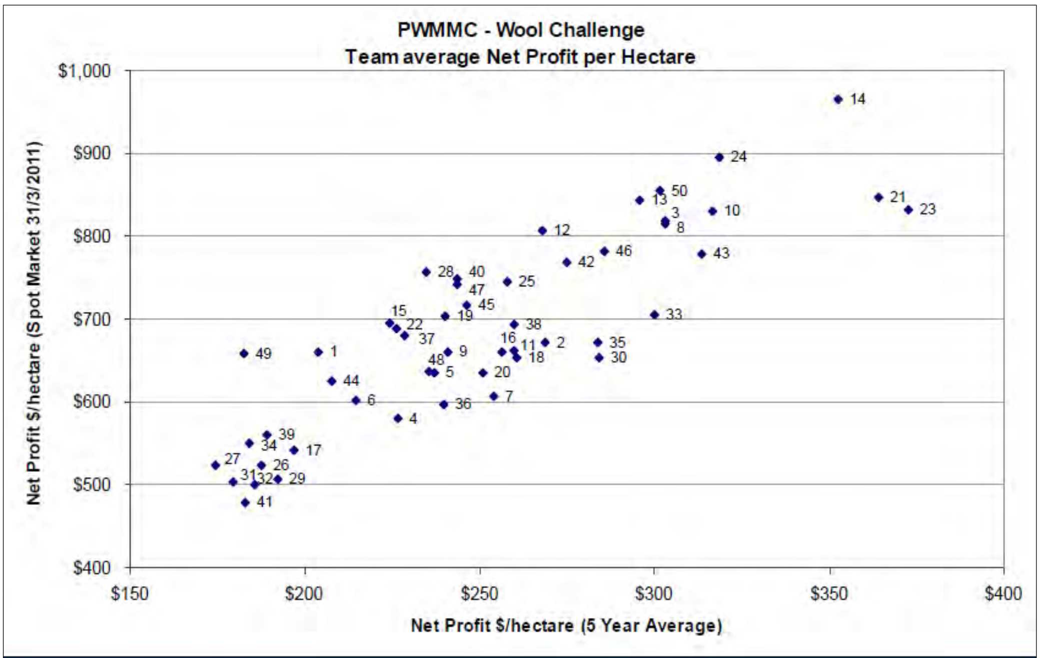
- Preliminary results based on the first wool assessment show a difference of from $86/head to $45/head for fleece and from $110/head to $70/head for carcase, using March/April 2011 wool and mutton prices.
- Taking into account both variable and overhead costs, the range in Net Profit per hectare was from $964/ha to $479/ha, a 101% difference at the same stocking rate.
- The higher valued teams required the same energy and costs as the lower valued teams yet were able to double the Net Profit per hectare.
- Growth Rates: average weight gain was 170g/day, team maximum weight gain was 204g/day and team minimum weight gain was 137g/day. The MSA requirement is 150g/day two weeks prior to slaughter.
- Over a 10 week period, this equates to an extra 4.7kg weight or $21.60.

Ref 34b

Net Profit per hectare

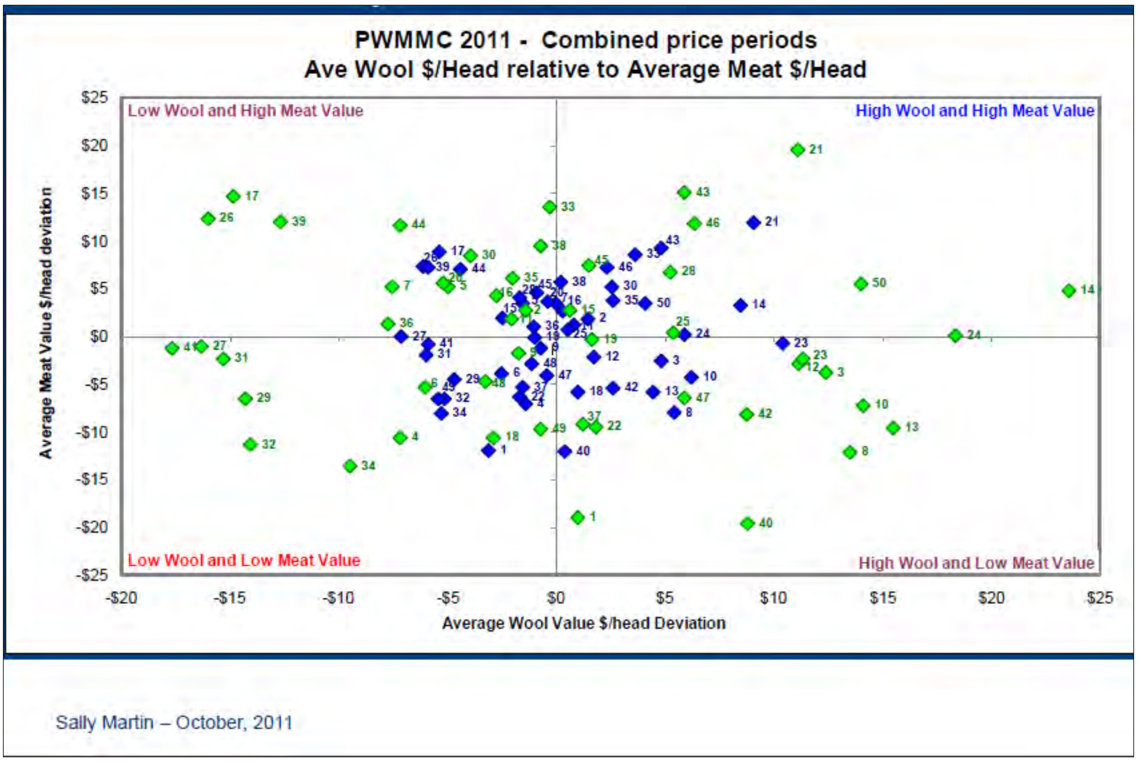
	Top 20%	Bottom 20%	Diff
5 Year Ave	$324.25	$185.20	$139.05
Current Market	$848.30	$523.84	$324.46
FD (um)	18.2	20.0	-1.7
CFW (kg)	4.2	3.7	0.6
Bwt (kg)	52.0	51.0	1.0

Sally Martin – October, 2011



Sally Martin – October, 2011

Ref 34c



Green diamonds: 2011 wool and carcase spot prices

Blue diamonds: 5 year average to 2011 wool and carcase prices

Number	35
Name	**Towards 13 Microns**
Traits researched	FD, CFW, SS
Date	1998 – 2007
Target audience	Ram breeders and buyers
Target	Wool
Source	CSIRO
Contact	Ian Purvis (CSIRO), Ph: 02 6776 1373 Andrew Swan (AGBU, University of New England), Ph: 02 6773 3209

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	Paper and presentation
File and format	**35a AAABG power point presentation** Swan_paper118.pdf **35b AAABG paper** Swan, AA, Purvis, IW. (2005) Genetic progress in the T13 Merino breeding program. *Proc. Assoc. Advmt. Anim. Breed. Genet.* ***16****: 165-168* 165swan.pdf **35c MERINOSELECT T13 Genetic Trends** MERINOSELECT Genetic Trends t13.pdf

Key Findings

- Significant genetic progress is predictable and achievable for ultrafine Merino producers.
- Using a simple design, a clear focus (breeding objective with corresponding index) and breeding values, significant genetic progress can be made.

Useful Information

- The breeding flock was founded in 1998 by CSIRO as a follow on from the Fine Wool Project.
- A consortium was formed in 2000, comprising CSIRO and 6 ram breeders.
- A base flock of 400 ewes was screened from CSIRO's Fine Wool Flock, but was open to new ram and ewe genetics from consortium members and the wider industry.
- Selection comprised using a 30%MP Index + 5% SS leading to maximum reduction in fibre diameter whilst maintaining other traits.

- Sires were selected by grower members.
- Data were recorded in Sheep Genetics up to the 2007 drop. Since then, the flock has been kept in a maintenance mode with very little recording. At the time of writing, the flock is still in existence.

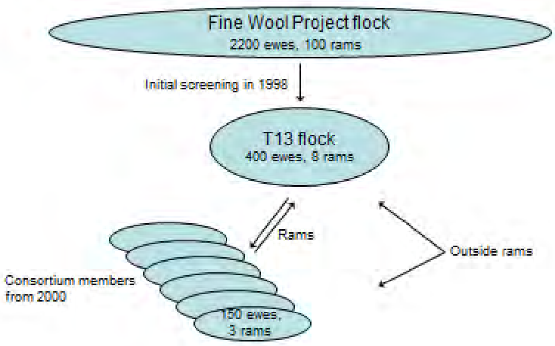
Background

The Towards 13 Micron (T13) breeding program was established by a consortium involving CSIRO Livestock Industries together with six ram breeders, with the objective of developing an ultrafine Merino flock capable of consistently producing wool at the finest end of the national wool clip. From the first mating in 1998, the flock was selected on a high micron premium breeding objective (30%) and a 5% premium on staple strength.

From the 2000 mating onwards, 8 rams were mated to 400 ewes annually using AI, with insemination taking place in early March. The rams were selected by the consortium members, and typically comprised 6 young rams from the central flock (15 months at the time of selection), an older ram to strengthen links to the previous drop, and an outside ram.

Ref 35a

2. Breeding program design



Genetic progress in the T13 breeding program

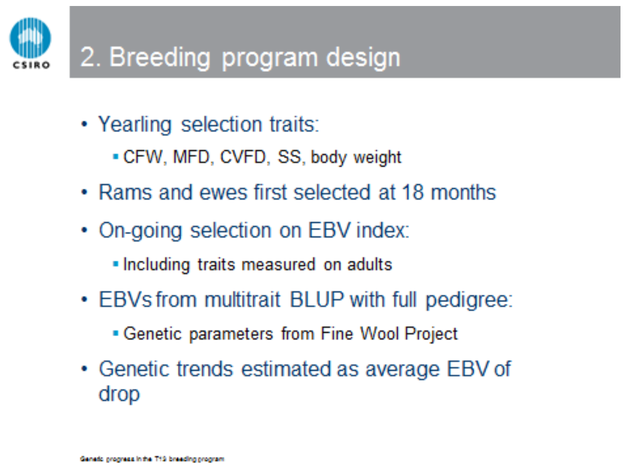
2. Breeding program design

- Breeding objective:
  - Maximum reduction in MFD while maintaining other traits
  - Index based selection :
    - 30% MFD and 5% SS price premiums

Micron premium	*Strength premium*	*CFW (%)*	*MFD (micron)*	*SS (N/Ktex)*
30%	*5%*	-5	-3.3	**0**

Predicted responses after 10 years of selection (CSIRO Fine Wool Project results)

Genetic progress in the T13 breeding program



Results

Ref 35b

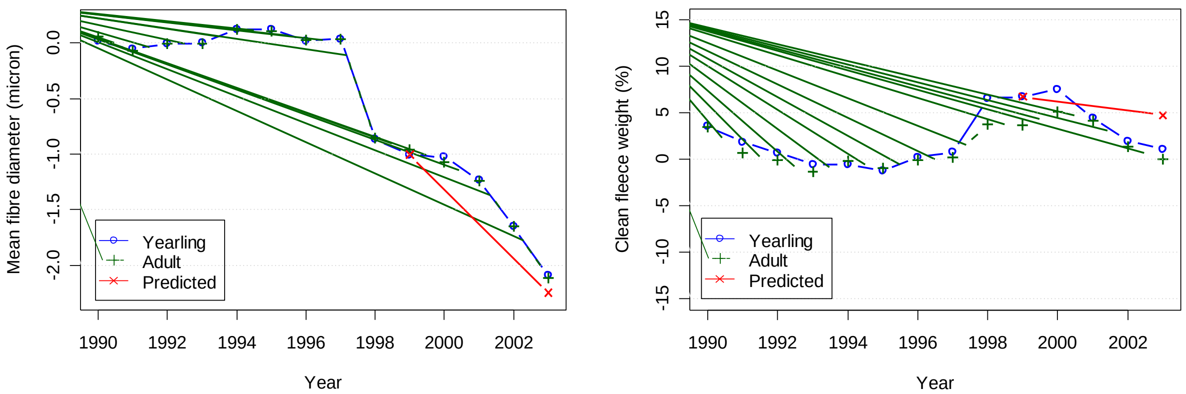
Between 1998 and 2003, the cumulative gain in the aggregate genotype of the breeding objective was approximately $40/ewe/year. The largest contribution to this improvement came from fibre diameter, which was reduced by 2 microns. After an initial increase in clean fleece weight, principally brought about by the capture of between bloodline genetic differences in the foundation animals, clean fleece weight reduced at the rate of 1.7% per year in yearlings, and 1.1% per year in adults.

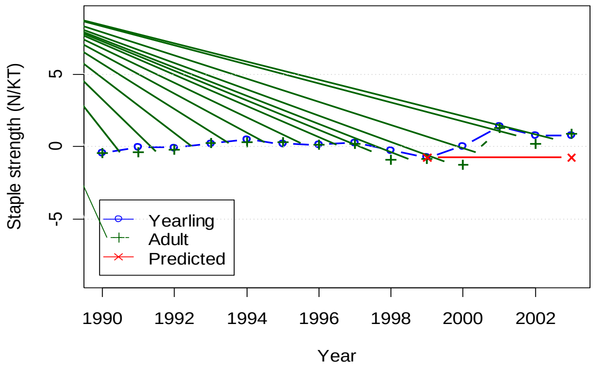
Ref 35a

Realised progress was close to expectation: FD was slightly lower than predicted (-0.28 cf. -0.33), there was greater loss in CFW than predicted (-1.7 cf. -0.5) and staple length was unchanged or slightly improved. A simple design but comprehensive recording program was very effective in maintaining focus.

From the 2004 mating, Total Genetic Resource Management was used to halt the reduction in fleece weight while still maintaining focus on the objective. Analysis of the impact of this change has never been undertaken but the MERINOSELECT trends below show that the strategy seems to have been effective.

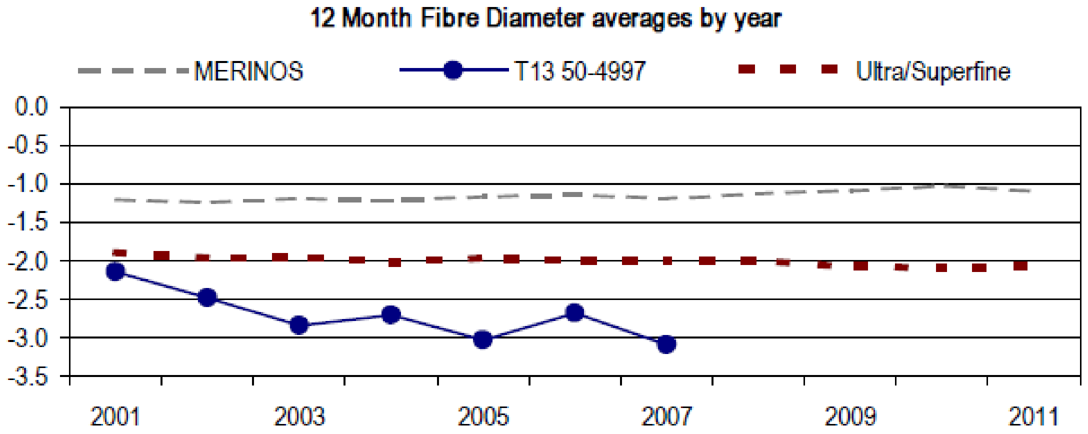
Genetic trends in the Fine Wool Project (1990 to 1997) and T13 (1998 to 2003) flocks for the breeding objective, mean fibre diameter and clean fleece weight.

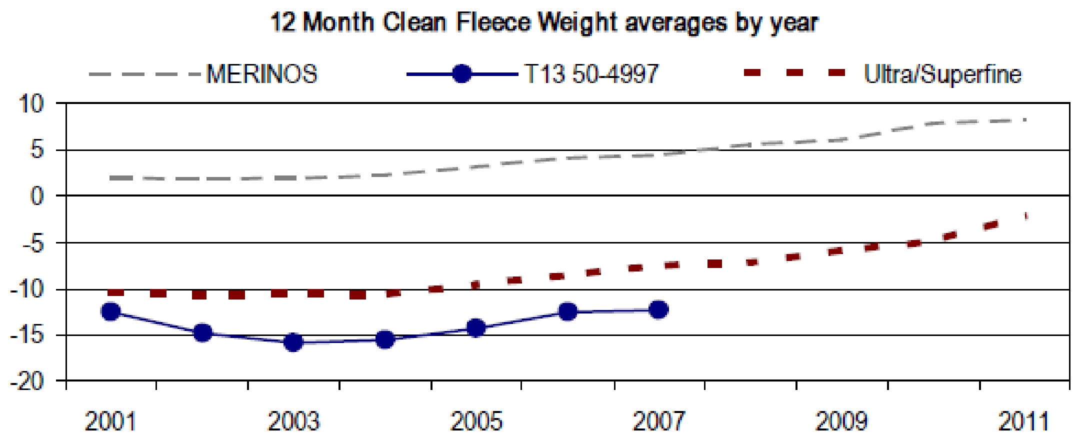


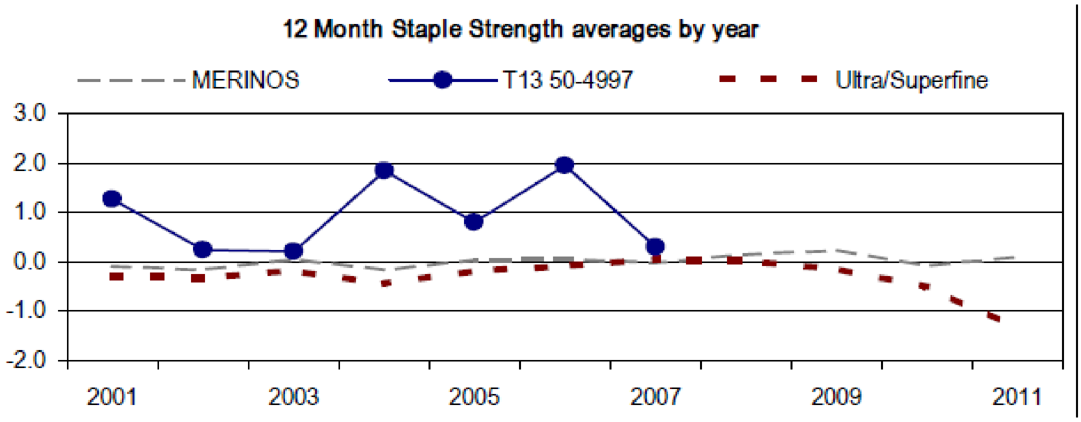


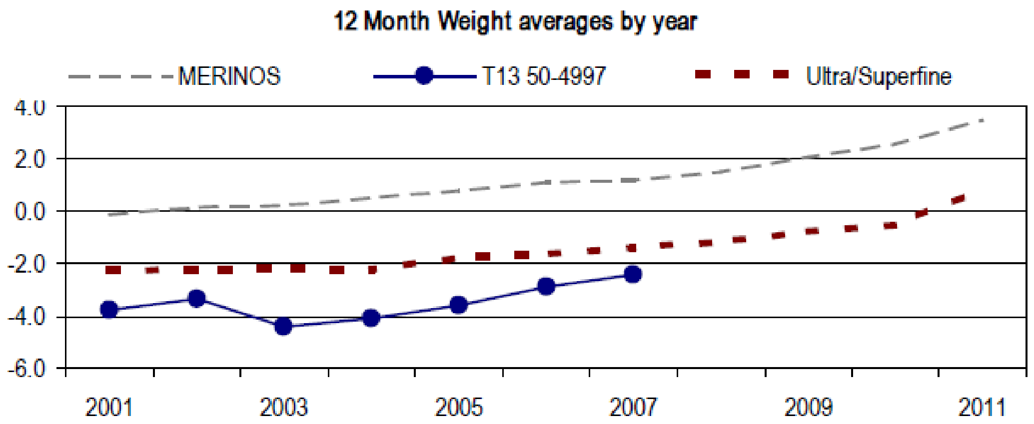
Drop	Yearling MFD		Adult MFD
	Ewes	Rams	Ewes
1998	15.3	15.5	17.6
1999	15.5	15.8	17.3
2000	15.8	16.1	17.0
2001	15.0	15.3	17.3
2002	16.0	16.2	16.8
2003	14.3	14.5	15.5
2004	14.5	14.2	

MERINOSELECT Genetic Trends ***Ref 35c***




12 Month Clean Fleece Weight averages by year
MERINOS
T13 50-4997
Ultra/Superfine
10
5
0
-5
-10
-15
-20
2001
2003
2005
2007
2009
2011


12 Month Staple Strength averages by year
MERINOS
T13 50-4997
Ultra/Superfine
3.0
2.0
1.0
0.0
-1.0
-2.0
2001
2003
2005
2007
2009
2011


12 Month Weight averages by year
MERINOS
T13 50-4997
Ultra/Superfine
4.0
2.0
0.0
-2.0
-4.0
-6.0
2001
2003
2005
2007
2009
2011

Number	36
Name	**Nemesis** Sustainable Control of Parasites – CSIRO/AWI
Traits researched	FEC, CFW, FD
Date	Extension project - April 2000 – May 2003
Target audience	Ram breeders and buyers
Target	Wool
Source	CSIRO, UNE, AGWA, IWS, AWI
Contact	Sandra Eady, CSIRO Livestock Industries, Ph: 02 6776 1394 E:Sandra.Eady@csiro.au Amy Bell Ph: 02 6776 1455 E: Amy.Bell@csiro.au
What's missing	Need more proof, lots of information about the facts but more case studies with the evidence?

Further Information

Permission	Yes Farming Ahead articles have been reproduced with the permission of Kondinin Group and Farming Ahead.
Summary of resources	Final report Nemesis brochure (provided separately and within final report) Articles
File and format	**36a** Nemesis Extension Project - Final report to AWI **36b** Nemesis CLI PDF Standard.pdf **36c** *Farming Ahead. No. 122. February 2002. 56* FA122-56-A_doyle.pdf **36d** *Farming Ahead No. 133 Jan 2003* FA133-58_amy bell nemesis.pdf

Key Findings

- The Nemesis project focussed on the selective breeding of Merino sheep as an effective and sustainable means to control internal parasites.
- FEC is a heritable trait – at approximately 25% - and selection over time will reduce the mean FEC of the flock.

- FEC is not strongly related to other production traits and can be incorporated into a selection index for ease of use and consistent application.
- FEC can be readily assessed and selected for (using the Nemesis guidelines).
- Lower FEC means less drench. It is predicted that it will take 9-13 years of consistent within flock selection to significantly change the worm burden and FEC of weaners so that they require less drenching.

Useful Information

- The final report for the extension project (***ref 36a***) captures a huge body of work around the development of breeding for worm resistance.
- Benefits of worm resistance include:
  - Fewer worms in sheep and less pasture contamination.
  - Healthier and more robust animals with lower mortality under a worm challenge.
  - Allows breeders to run sheep in districts where there is total drench resistance.
- Eady (***ref 36a*** *page 132*) cites the success of many historic research flocks in reducing faecal egg count under natural or artificial challenges

Background

Ref 36a

Nemesis was the national technology transfer project which aimed to develop systems for incorporating resistance to worms into Merino breeding programs. The goals of the extension project were to refine existing technology and increase the number of worm-resistant rams available to industry.

The original Nemesis program commenced in the 1990s with CSIRO as the lead agency. The original program worked directly with growers to develop guidelines for sampling and for breeding. The result of this work saw a growing number of ram breeders breeding for worm resistance ***(ref 36a).***

Results

Is it possible to breed for low FEC?

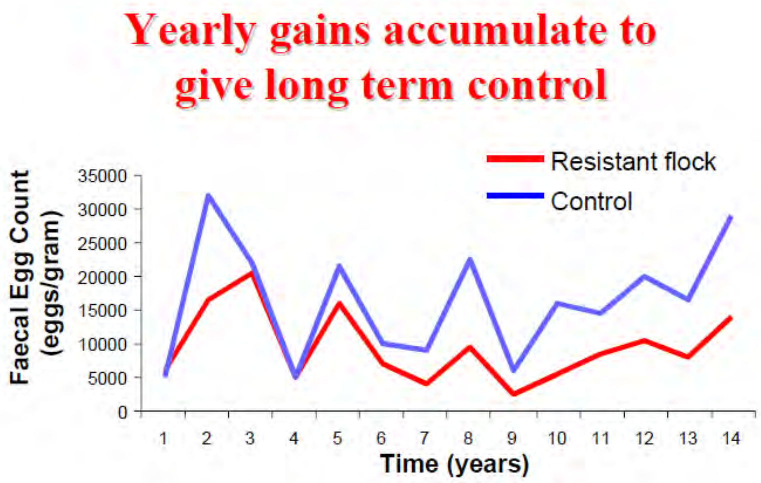
- Heritability of faecal egg count in Merino sheep is between 0.2 – 0.3 under a typical worm challenge.
- While this heritability may be relatively low compared to production traits (which range between 0.3-0.5), it is still high enough to allow a response to selection.
- Worm resistance is an extremely variable trait with a coefficient of variation often greater than 100%, compared with 10-15% in commonly measured traits such as fibre diameter and body weight. This means the difference between the best and the worst animal in a mob is very large, a factor that aids in selection for worm resistance.
- Extensive studies with Merinos across Australia in the early 1990s showed that there was no particular ram breeder with the potential to have more resistant rams than any other, even those that come from a 'wormy' environment. On the other hand, each breeder has the potential to improve worm resistance by identifying sires that have superior resistance.

How long will it take?

- In the CSIRO Barbers Pole selection lines using within flock selection, it took about 8 years of selection to give consistently lower FECs in the resistant line. Since then, FEC has been decreasing consistently with each year's selection of resistant sheep (see Figure 1).
- Although the change in any one year is small, it is a permanent improvement in resistance and the animals carry fewer worms, causing significantly less pasture contamination than unselected sheep.

- Although the Barbers Pole lines were selected solely on FEC, selection pressure was reduced to avoid inbreeding in the 120 ewe flock. It is estimated that the amount of selection pressure on FEC in the flock was equivalent to using 70% of the possible selection pressure for worms (Worm70 Index).

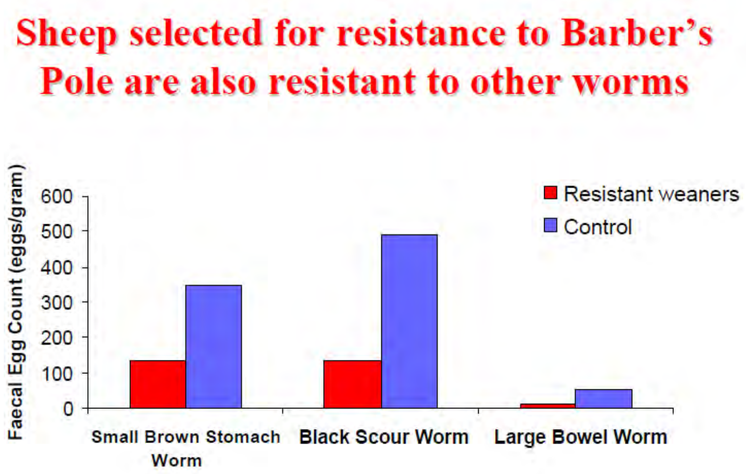
Figure 1. Faecal egg count of weaners from Barbers Pole selection flock after artificial worm challenge



Are sheep selected for resistance to Barbers Pole also resistant to other worms?

- During a natural worm challenge, animals are exposed to more than one worm species. Experimental animals selected for resistance to one species have shown lower worm burdens to a range of worm species.
- This cross resistance was demonstrated in the CSIRO Barbers Pole selection line when animals were found to pass fewer Black Scour Worm and Small Brown Stomach Worm eggs when grazing contaminated pastures, even in the absence of Barbers Pole (see Figure 2). Similar results have also been found in animals selected for resistance to Black Scour worm.
- Cross resistance is of practical importance to ram breeders and their clients, as the predominant worm species in the stud environment may be different from that on clients' properties. Cross-resistance is also important as worm species in natural worm infections vary from year to year.

Figure 2. Cross resistance to other worm species demonstrated in the Barbers Pole selection flock



Incorporating the resistant trait into your breeding program

- Faecal egg count EBVs can be incorporated into a selection index with other measured traits. The amount of emphasis to be placed on worm resistance in the selection index will need to be decided by the individual breeder.
- Once the amount of emphasis has been decided, one can see how it influences the individual rams chosen as replacements by looking at all the indices, as shown in Figure 6. In the No Worm Index the best 30 rams are selected using production traits and no emphasis on worm resistance. These are the red dots to the right of the line.
- The identity of the best 30 rams changes as more emphasis is placed on worm resistance. The WORM 50 and WORM70 indices show that highly productive rams can also be extremely resistant.

Figure 6. Comparison of different selection indexes, with the best 30 rams se

(•) when there is no, moderate or high emphasis on worm resistance

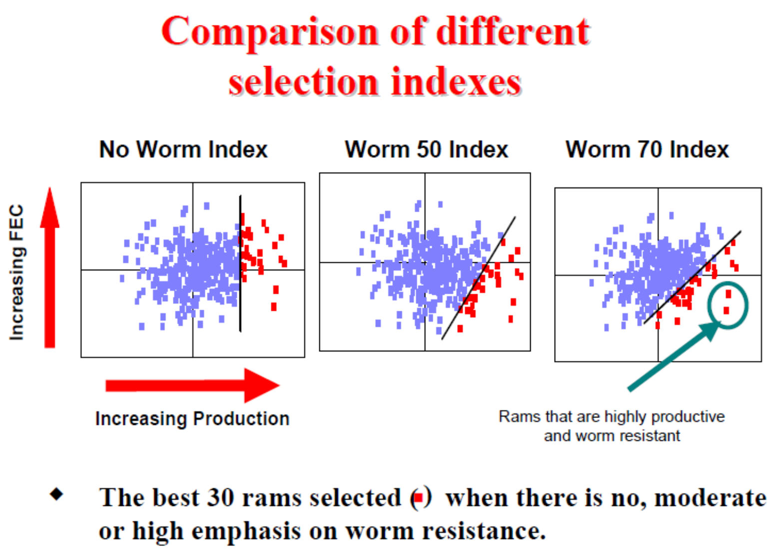
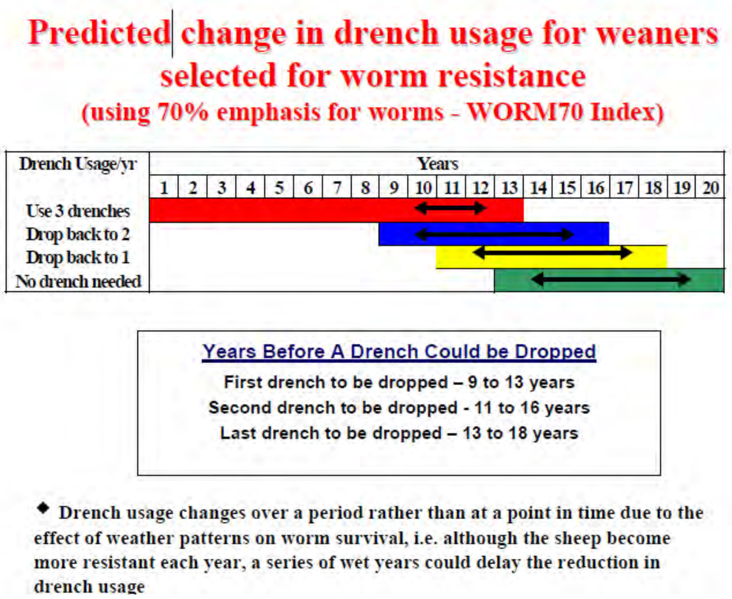


Figure 7. Change in drenching frequency for a flock selected for worm resistance



Case Study – Ruby Hills – ref 36a page 74 (historic case study)

Andrew Burgess of Ruby Hills, in the New England region of NSW, began selecting for worm resistance in 1992, due to growing concern about drench resistance and the prediction that current drenches used on his property could be ineffective within 10 years. He was further encouraged to commence a selection program when he saw that the amount of variation in FECs in his own sheep mirrored that seen in research flocks where substantial genetic gain had been shown to be possible.

In his breeding program Andrew has employed a selection index to rank his animals. This index was designed to make 50% of the possible gain in worm resistance while optimising gain in fibre diameter and clean fleece weight at a micron premium of 3%. Andrew has recently changed to an 8% micron premium, which moves more emphasis onto reducing fibre diameter, and he has also added staple strength into the index. However, he still places the same selection pressure on worm resistance. Figure 13 shows the genetic trend, from 1990-1999, for fleece traits and worm resistance (as indicated by FEC) at Ruby Hills.

Selection for low FEC has been integrated with other worm control practices used on the property over this time, such as grazing strategies with cattle rotations, slow release capsules in lambing ewes and the use of Rametin® with Benzimidazole and Levamisole drenches.

Within the last few years, Andrew has noticed a decline in drenching frequency, especially in the stud flock, as the level of resistance in his sheep has increased. This has given him much more confidence that the useful life of drenches on his property will be extended.

One of Andrew's ram buying clients has compared the progeny of resistant rams with susceptible ones on his own farm. The weaners sired by resistant rams tended to have a higher survival rate and a 1kg bodyweight advantage. The differences were only small which was to be expected as breeding for resistance is a slow process, but it does yield permanent returns.

The first five or so years selecting for worm resistance at Ruby Hills showed little practical evidence of change in resistance of the flock, as the effects of current rams were still being carried through. However, Andrew Burgess states that now "each year is getting better - most of the 98 drop have negative FEC EBVs, which makes selection easier".

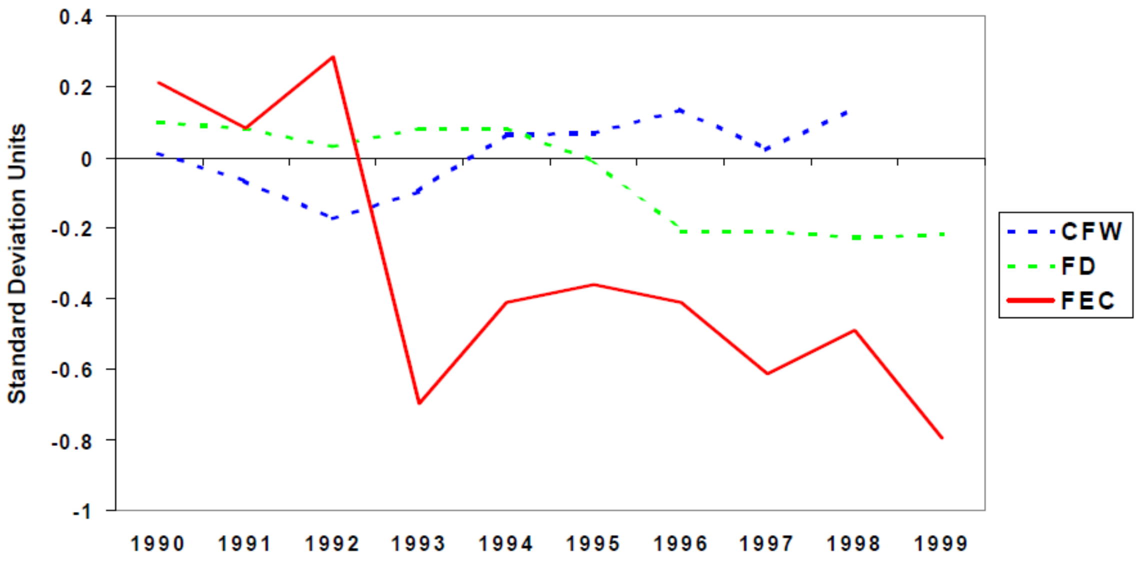


Figure 13. Ruby Hills genetic trend for clean fleece weight (CFW), fibre diameter (FD) and faecal egg count (FEC).

Case Stud – Billandri Poll Merino Stud - *ref 36a page 76 (historic case study)*

Bill Sandilands of "Billandri" in Kendenup, south western WA, has been selecting for worm resistance since 1993. Agriculture WA and the Nemesis project invited Bill to be part of a group of breeders incorporating worm resistance into a commercial ram breeding program.

Bill's initial reaction was reluctance to increase the number of traits under selection, thereby reducing the selection pressure on each trait. However, drench resistance testing on the property showed both white and clear drenches and their combination to be ineffective, prompting the decision to begin breeding for resistance to worms.

The selection index used at Billandri aims to increase clean fleece weight by 0.24 kg, increase staple strength by 1N/kt, decrease fibre diameter by 1µm and maintain body weight over ten years of selection. The index also incorporates worm resistance at Worm 50, which is designed to make 50% of the possible gain in worm resistance while optimising gain in the other traits. The decision to use a Worm 50 index, rather than an index with lower selection pressure for worms, was made to improve worm resistance at a faster rate.

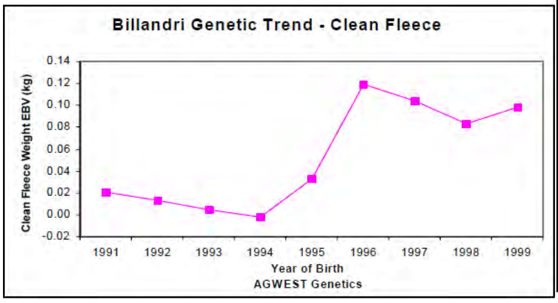
Breeding is an essential part of worm control at Billandri, along with a normal two summer drench program for weaners. The use of alternative worm control methods, such as cattle and wether rotations are not used, so as to maximise the number of breeding ewes in the flock. A gradual increase in the level of resistance in the flock over time will assist in prolonging the life of current drenches used on the property by reducing frequency of use.

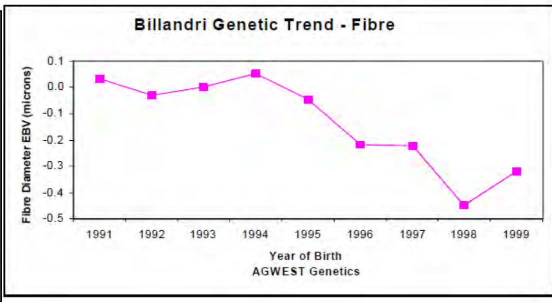
Pressure by clients wanting to buy resistant rams has prompted neighbouring ram breeders to approach Bill and ask how to go about breeding for worm resistance. Some of these breeders have bought rams from Billandri to begin selection. At Billandri ram sales, an encouraging percentage of buyers are targeting rams with better than average worm resistance (rams with negative FEC EBVs), indicating a growing awareness in the sheep industry for the need to breed resistant sheep.

Bill is confident that as time goes on the resistance level at Billandri will increase throughout the flock and the merit of breeding for resistance will become more apparent in the management of the property.

The advice Bill would give to sheep producers, considering breeding as an alternative control, is to be prepared to take accurate faecal samples at the correct time when worm burdens are suitable and use the worm index stringently. Worm resistance has a relatively low heritability compared to other traits, emphasising the need for accuracy. In the first year of selection Bill found that the top ranked ram for production had the highest faecal egg count. Even though it was a difficult decision, this ram was not retained as a sire. Each year Bill has noticed that there are high performing rams with high FEC and there are high performing rams with low FEC. If the long term goal is worm resistant animals, then the consequence is that the high FEC rams must be culled from the flock, no matter how good they are for production traits.

Figure 14 shows the genetic trends over the last 9 years at Billandri for fleece weight and fibre diameter, and the trend in FEC since worm resistance was included in the breeding objective.





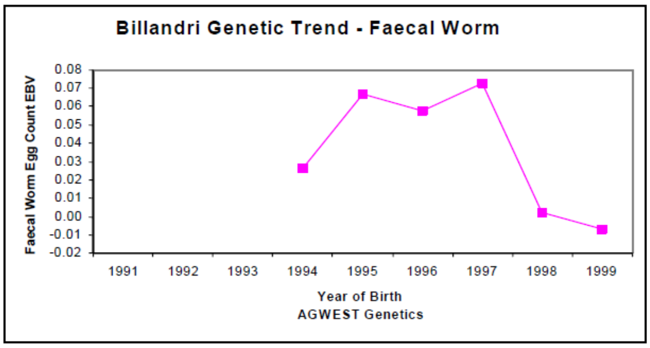
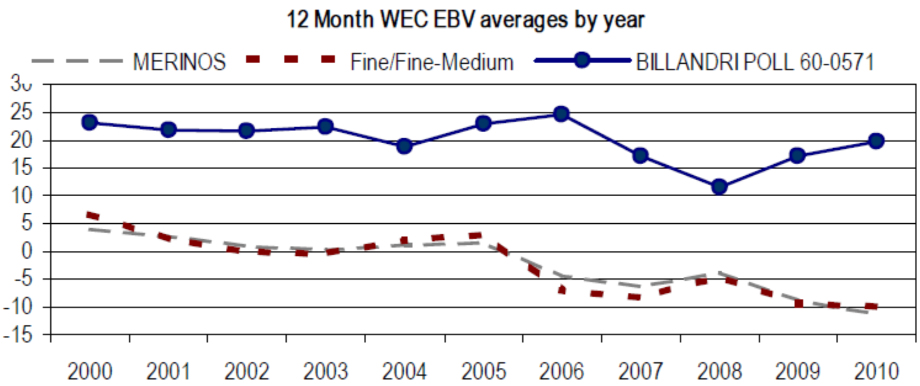


Figure 14. Genetic trends over the last 9 years at Billandri for fleece weight and fibre diameter, and trend in FEC since worm resistance was included in the breeding objective.

2012 Update - Billandri Poll Merino Stud

The Sandilands continue to select for resistance to worms in their flock. They complete their own egg counting but have found that every second year the counts haven't been high enough for selection purposes. As a result the progress in breeding for resistance to worms hasn't been as great as they would have liked.

Other factors have also contributed to the progress achieved to date. The family are reluctant to subject rams to high worm burdens close to sale time plus a number of other traits have been included in the Billandri personalised index (in 2005) which has reduced the emphasis on WEC to 19%. The following chart shows the current Billandri genetic trend as reported by MERINOSELECT in October 2011.



Number	37
Name	**Better breeding**
Traits researched	FD, GFW, WT and visual culling per cent
Date	July 1997 – June 2001
Target audience	Ram buyers
Target	Wool
Source	PIRSA, AWI, Advisory Board of Agriculture
Contact	Brian Ashton, M: 0438 088 220 E: ashtonba@gmail.com

Further Information

Permission	Yes Farming Ahead articles have been reproduced with the permission of Kondinin Group and Farming Ahead.
Summary of resources	Article in Farming Ahead Paper
File and format	**37a** Farming Ahead FA97-64.pdf **37b** AAABG paper Singh, A.W., Richardson, W.B., Ashton, B.L., Manson, D.A. (1999). Better breeding : improving returns through better ram selection. *Proc. Adv. Anim. Breed.Gen. (1999) 13: 428-431.* AB99101.pdf

Key Findings

- This was an extension project aimed at commercial woolgrowers to increase returns through more objective ram selection.
- The project relied on the “action learning” process: that producers will learn by trying something new and evaluating the results.
- The project involved workshops and on-farm ram evaluation trials (65 trials involving 70 different bloodlines).
- The evaluation trials had clear guidelines to ensure fair comparisons (similar management, equal genetics, etc.).

Note

- Ewe trials, wether trials and sheep productivity trials emphasise a large variation in the genetic performance between animals. Superior performance in these trials is at times attributed to the

incorporation of advanced genetic technologies like breeding values and indexes or the inclusion of objective measurement in selection programs. They also stress the need to use tools that describe genetic differences when making ram and sire choices.

Useful Information

- Commercial breeders were challenged:
    - To set clear breeding objectives;
    - To find a ram source that provided objective information;
    - To run progeny comparisons on their own farms; and
    - To evaluate the ram selection decision.
- On-farm trials usually involved the purchase of 5 rams from a new source and joining them to a random mating of at least 250 ewes.
- Growers were encouraged to observe differences in pigmentation, fleece rot, fly strike, wrinkle and other visual traits. Independent sheep classers were used where possible.
- During the four years of the project the premium for fine wool became extreme. This somewhat distorted the original aims of the project.
- This became a very politically sensitive project within South Australia and this information should be used in consultation with the contact detailed above.

Background

Ref 37b

This project was created in the late 1990s to stimulate the rate of genetic gain in the South Australian Merino industry. Ram selection had predominantly been visually based with objective measurement used to a lesser extent. The focus of the project was to work with commercial woolgrowers to help them:

- Realise that ram selection is important to their business.
- Purchase rams with a view to the performance of their offspring and not just the performance, or looks, of the ram.
- Seek more objective information on which bloodline to choose and then on which rams to choose within that bloodline.
- Evaluate their decisions by running on-farm trials to compare the offspring.

The extension project involved a range of activities. A key part of the project was to lead groups of producers through an on-farm trial to put into practice what had been learnt by participating in the project workshop. 65 ram evaluation trials were undertaken with over 70 bloodlines represented.

Results

Some of the on-farm trial results were collated but are not provided here because they are incomplete. Some individual trial results are offered but should be considered as examples only:

Ref 37a - Summary of trials involving the introduction of a particular new bloodline. Variations from the home bloodline are shown before adjusting for hybrid vigour. Fleece values are calculated using 1997 prices.

Location	Fleece weight (Greasy kg)	Fibre diameter (micron)	Yield (%)	Bodyweight (kg)	Culls (%)	Fleece value ($)
Tungkillo	+0.2	-1.6	+1.0	-0.5	-6.5	6.2
Tungkillo	+0.4	-0.7	-2.0	+1.3	-4.0	3.7
Eden Valley	+0.1	-1.7	+5.4	+0.3	-0.5	6.1
Milang	+0.9	-1.4	-1.1	NA	NA	8.8
Mid North	+0.3	-1.7	+1.9	+1.1	NA	7.1
Karoonda	+0.3	-0.3	0	-2.1	0	2.1
Broken Hill	+0.1	-1.1	+2.0	-4.7	-13.0	3.6

Number	38
Name	**On-Farm Progeny Testing**
Traits researched	FD, CFW, CV,
Date	1997-2001
Target audience	Ram breeders and buyers
Target	Wool
Source	DPI Vic
Contact	Lyndon Kubeil M: 0418 532 085 E : lyndon.kubeil@dpi.vic.gov.au
What's missing	

Further Information

Permission	Yes. Please cite the journal source when using in future publications.
Summary of resources	Final report Published papers
File and format	**38a** *Final Report* FINAL milestone report (Vic DPI Increasing Demand for Objective Evaluation of Wool Sheep).pdf **38b** *Paper* Pollard, T., Ferguson, M., Konstantinov, K., Kubeil, L. and Heazlewood, P. (2002) Demonstration of Variation in Merino Sire Performance using Onfarm Progeny Testing. *Anim. Prod. Aust. 2002 Vol. 24: 340* pollard1C.pdf **38c** *Brien Paper* BRIEN, F.D. and KONSTANTINOV, K. (2001) Benchmarks for productivity of wool sheep in southern Australia. *Proc. Aust. Sheep Veterinary Society Conference* May 2001 Vol 11: 88-91.

Key Findings

- Results demonstrate the genetic variation which exists in the Merino population.
- Results also demonstrate the potential that exists for commercial woolgrowers to exploit this variation and improve their profitability when provided with the appropriate tools and information to make better ram-purchasing decisions.
- The greatest difference in fleece value between the progeny from individual sires was $19.06/hd based on 5yr average wool prices and the average was $7.25/head.
- The greatest difference in fleece value between progeny groups of different ram sources ranged from $0.58/hd to $5.62/head.

Useful Information

- “Rampower” protocol was used to provide the basis for the set-up of each progeny test site and the sampling and subsequent testing procedure.
- Allocation of ewes to mating groups was conducted by random allocation under the supervision of project staff.
- Each ram was mated to 35 to 50 ewes.
- Wool prices were AWEX 5 year average wool prices.

Background

This project aimed to demonstrate to commercial woolgrowers the variation which exists between and within bloodlines, improve their understanding of objective measurement and increase demand for valid objective information on the rams that they purchase. On-farm progeny testing was used to demonstrate the importance of using measurement when breeding sheep and especially when selecting rams.

Progeny testing case studies have been conducted on 46 properties between 1997 and May 2001. Since commencement, two hundred and sixteen individual sires have been tested, and a total of 7,668 progeny have been measured. Eleven properties have conducted ram source comparisons, comparing 23 different ram sources. A total of 3,663 progeny of 141 rams have been measured.

Results

Individual Sire Comparisons

Two hundred and sixteen individual sires were tested. A total of 7,668 progeny were measured in this trial. Within each evaluation group, the number of individually mated sires ranged from 2 to 15. The results of this project show that large variation exists between rams in the performance of their progeny. The greatest difference in fleece value between the progeny from individual sires was $19.06/head based on 5-year average wool prices and the average was $7.25/head.

EBVs were calculated for individual sires where possible to enable identification of genetically superior rams. The greatest differences in the sire EBVs was 3.9 micron (average 2 micron) for fibre diameter and 54% (21% average) for greasy fleece weight.

Ram source Comparisons

Eleven properties have conducted ram source comparisons, comparing 23 different ram sources. A total of 3,663 progeny of 141 rams were measured in these comparisons. Results from comparisons between ram sources varied considerably. The differences in fleece value between the progeny groups of different ram sources tested ranged from $0.58/head to $5.62/head, and the average difference between ram sources was $2.01/head.

While these differences were less dramatic than the individual sire differences, the growers and associated groups involved showed great interest in the results.

Ref 38a **Sample of on-farm ram comparison - from the final report**

Ram	MFD	SD	CV%	Curv	Yield	GFW	CFW	Fleece Value 5yr. Av.
AV49	17.8	3.71	20.8	109.9	67.7	3.11	2.12	**$26.16**
N14	17.4	3.65	21	102.3	67.5	3.41	2.31	**$32.09**
N25	17.8	3.67	20.6	100.3	66.2	3.39	2.25	**$27.77**
N40	17.7	4.22	24	99.4	66.1	3.56	2.36	**$30.04**
Average	17.68	3.81	21.60	102.98	66.88	3.37	2.26	**$28.98**

Ref 38b

Table 1. Mean and maximum differences in sire performance for 35 test sites

	Max. sire difference*	Mean sire difference over all sites
EBV+ Fibre diameter (microns)	3.9	2.0
EBV Fleece weight (%)	54	21
Fleece value ($)▲	19.06	7.25

*Site showing the greatest difference in performance between best and poorest rams.
▲ Based on 5-year average wool prices. +Estimated Breeding Value

Eleven properties conducted ram-source comparisons, comparing 23 different bloodlines. A summary of the results is given in Table 2.

Table 2. Mean and maximum differences in bloodline performance for 11 test sites.

	Max. bloodline difference*	Mean bloodline difference over all sites
Fibre Diameter (microns)	1.0	0.5
Fleeceweight (kg)	0.55	0.21
Fleece Value ($)▲	5.62	2.20

*Site showing the greatest difference in performance between best and poorest bloodlines.
▲ Based on 5-year average wool prices.

Ref 38c

Brien and Konstantinov (2001) cleaned the data from the trials to generate phenotypic and genetic relationships between traits.

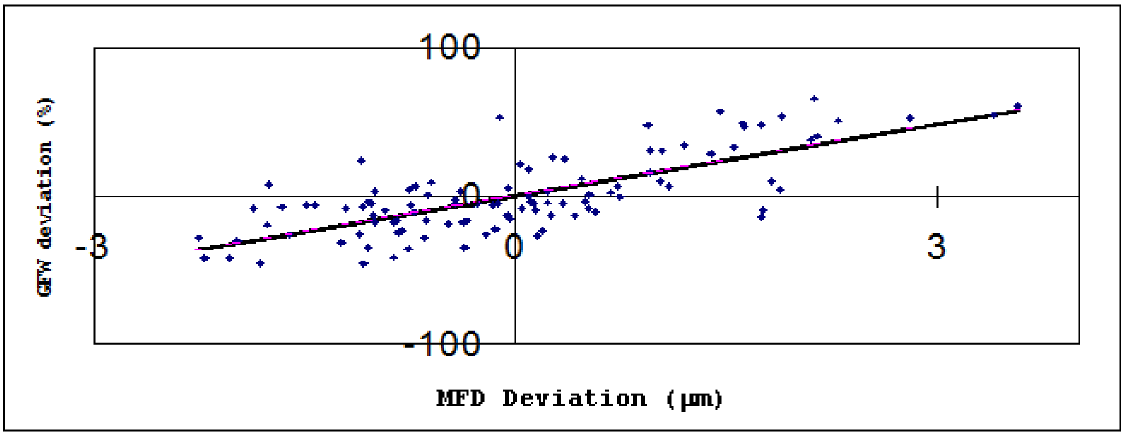


Fig 1. Phenotypic relationship between MFD and GFW%

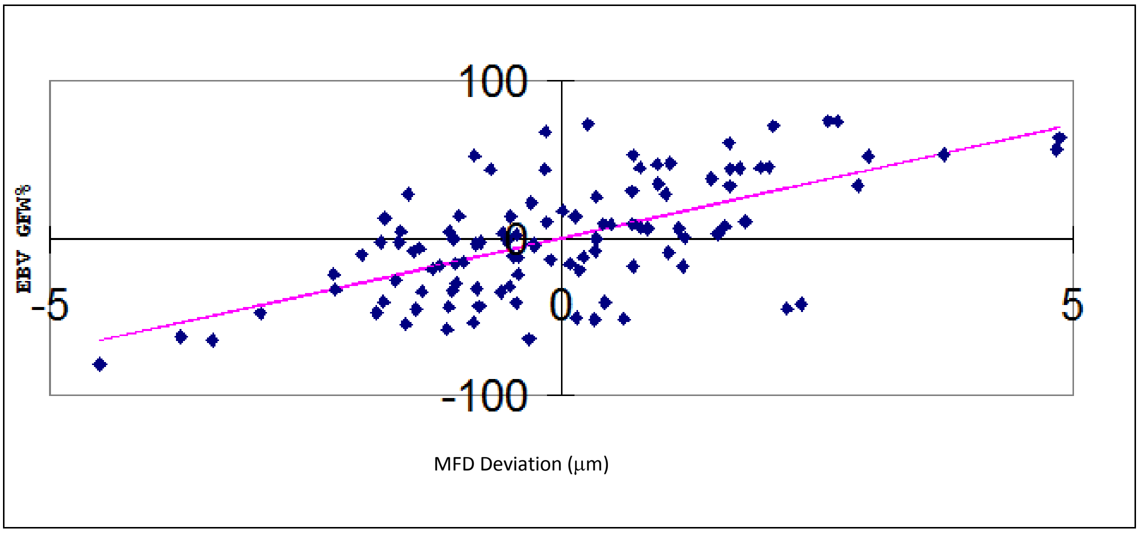


Fig 2. Genetic relationship between MFD and GFW%

Number	39
Name	**Merinos to Match**
Traits researched	GFW, CFW, FD, CV, SS, WT, EMD, FAT
Date	2004-2005
Target audience	Ram breeders and buyers
Target	Wool
Source	DPI Vic and Vic SMSBA, (carcase funded by MLA)
Contact	Jane Court, Vic DPI, Ph: 03 5735 4351 E: jane.court@dpi.vic.gov.au
What's missing	Site reports. Updated financial analysis could be done

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	Final report
File and format	**39a** *Final Report* Final across site report November 2006 email.pdf **39b** *AAABG Paper* Court, J.E., Hallam, G., Kubeil, L., Kaine, G. (2007) Sheep Breeding and Selection – Targeting the Audience. *Proc. Assoc. Advmt. Anim. Breed. Genet.* ***17****: 529-532* 529 court529.pdf **39c** *ASAP* Brien, F; Court, J; Hallam, G; Keating, D; Kubeil, L; Konstantinov, K; Stapleton, P. (2004) Benchmarking Merino studs : the Merinos to Match project. *Proc. Aust. Soc. Anim. Prod. (2004) 25: 17-20* BRIEN017.pdf

Key Findings

- Merino to Match was designed to evaluate Merino studs across a range of Victorian environments in response to market research that identified genotype by environment and selection criteria concerns affecting bloodline selection.
- 29 stud teams from four states were evaluated over four Victorian sites and have been reported as site reports for 2004 and 2005 but also combined across sites using link teams.
- Linkages were established across sites and no re-ranking was observed in the across-site analysis.
- There was variation in stud performance but also large variation within studs generally.

Note

- Ewe trials, wether trials and sheep productivity trials emphasise a large variation in the genetic performance between animals. Superior performance in these trials is at times attributed to the

incorporation of advanced genetic technologies like breeding values and indexes or the inclusion of objective measurement in selection programs. They also stress the need to use tools that describe genetic differences when making ram and sire choices.

Useful Information

- Each stud was represented by a team of 24 wethers sourced and randomly selected from three long-term client flocks.
- All sheep were assessed for wool and carcase traits, including fleece rot.
- Only second year shearing results were used in the across site analysis to ensure that the effect of mixed ages was minimised.
- Each site was established by local groups who selected and invited studs to participate: Hamilton, Stawell, Dookie and Elmore.
- EBVs from standard MERINOSELECT indices were used to predict financial advantages and to recognise the difference in breeding objectives when selecting studs.

Background

The "Merinos to Match" project was designed to be useful to all Victorian wool producers by providing them with information that fitted within their belief systems (discussed further in ***refs 39b*** *and* ***ref 39c***).

Four trial sites evaluated twenty-nine studs. Of these, many had not been involved in benchmarking through wether trials or sire evaluations previously and so this was gauged as a success in attracting a wider range of studs relevant to wool producers. Each site collected data on fleece weight, fibre measurements, fleece rot and bodyweight for two shearings. Fleeces were assessed for greasy colour and style using the AWEX scoring system. Fat and eye muscle depth was measured in the first year, as was crimp frequency. The data was analysed using ASREML software (Gilmour et al, 2000) and the average standard error of difference for each trait was provided as a measure of 'real' differences between studs. The across-site analysis model included fixed effects of site, age at first shearing and birth month. Taking these factors into consideration had the impact of reducing the size of some of the differences between studs.

Three breeding indices were estimated for each stud in the across-site analysis using relative economic values, to identify financial advantages from changing stud source, for different breeding objectives. These indices used relative economic values used by Sheep Genetics in the indices they provide to Merino ram clients (Kevin Atkins, pers. comm.).

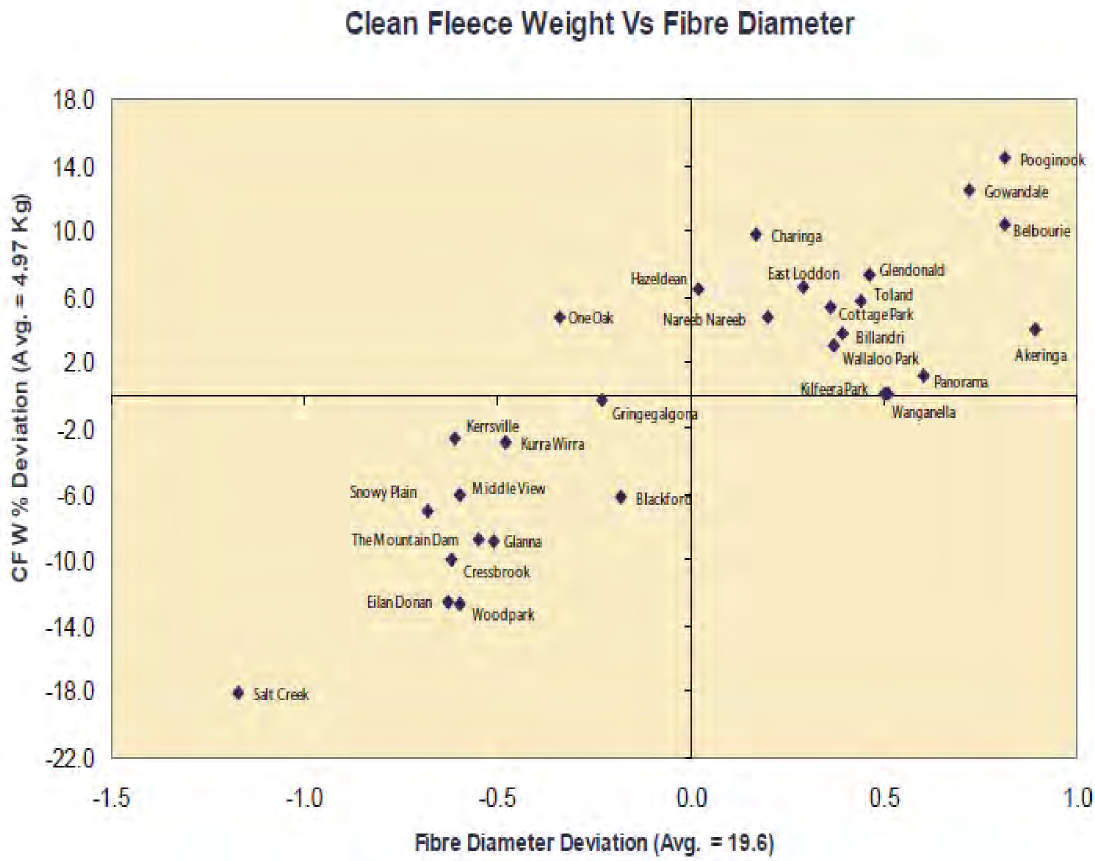
Results

Ref **39a**

There was no re-ranking observed in the across-site analysis. Studs that had teams at more than one site performed consistently.

Stud performance differences:

- Range across teams of 2.1µ in mean fibre diameter.
- 32% in greasy fleece weight and 30% in clean fleece weight.
- Yields varied by over 5%.
- Staple length varied by 14.8mm.
- Staple strength by 5.1N/Ktex. Some of the finer teams had the highest staple strength.
- For fat and eye muscle depth, the differences were not large (2.5mm for eye muscle and 1.1mm for fat) but they were significant.



Ref 39b

- The range between best and worst studs for a particular breeding objective was between $2.60 to $3.41/Dry Sheep Equivalent (DSE)/year. A description of the methods used and these results are in the final report (see ***ref 39b***). Whilst these differences can yield large returns when extrapolated to large numbers of ewes, this is approximately a quarter of the differences reported in the NSW bloodline analyses, (Atkins et al 2005) acknowledging a narrower range of Merino types and a different economic analysis.
- Results indicate that this did attract the full spectrum of producers and provide them with useful and valid information on ram sources. The lack of differences between some studs reduced the potential for change by many producers. Developing strategies to fit within beliefs, rather than attempting to change beliefs in the short term, was successful in attracting a wide audience which was receptive to adopting change if potential was identified. In the long term, these beliefs need to be broken down to achieve maximum uptake of genetic information without the expense of these replicated trials.

Number	40
Name	**Turkey Lane – A commercial example of success**
Traits researched	CFW, FD
Date	2000-continuing
Target audience	Ram breeders and buyers
Target	Wool
Source	NSW DPI
Contact	Jo and John Symons, Turkey Lane, Ph: 08 8559 2234 E:j.jsymons@bigpond.com Allan Casey, NSW DPI, Ph: 02 6391 3812 E: allan.casey@dpi.nsw.gov.au

Further Information

Permission	Yes
Summary of resources	Power point slides Qplu$ Field Day Paper
File and format	**40a** PowerPoint Slides – Pop_wool_160708 variation.ppt **40c paper on page 47** CE Pope (editor), Trangie Qplu$ Merinos – Open Day 2006.ppt

Key Findings

- A commercial Merino flock used across-flock benchmarking and index selection to improve income dramatically by 18%.
- Using longer term market values, the increase in profits would have exceeded 50%.

Useful Information

- Economic figures based on 2006 prices.
- The aim was to maintain wool cut and significantly reduce micron.

Background

Turkey Lane started breeding rams in 2000 to make radical genetic change to their flock's production. The breeding objective of the Turkey Lane flock set and publicly reported in 2000 aimed at producing at least 50 kgs greasy wool per hectare of 20-micron wool by the end of 2006. In the 1998/99 production year, the flock produced was well above district average wool cuts: 49.3 kgs greasy wool per hectare at 23.3 microns average diameter, stocked at 11.8 DSE per hectare. The breeding objective also included an improvement in the flock's reproductive performance and the addressing of the high incidence of fleece rot that occurred each year. To achieve the Turkey Lane breeding objective and avoid disease risks, a small ram-breeding nucleus of selected

Turkey Lane ewes was established and AI was used to introduce sires selected from Merino Superior Sires and Merino Benchmark. An index based on the Turkey Lane breeding objective and breeding value performance was used to select the introduced sires as well as the rams and ewes bred in the nucleus.

- 1998/99 production levels:
  - 51 kgs GFW per hectare.
  - 23.3 micron average clip diameter.
  - 65% marking percentage.
  - $169.62 gross sheep income per hectare.

- Aim by 2006
  - 50kgs GFW per hectare .
  - 20 micron wool.
  - at least $300.00 gross sheep income per hectare.

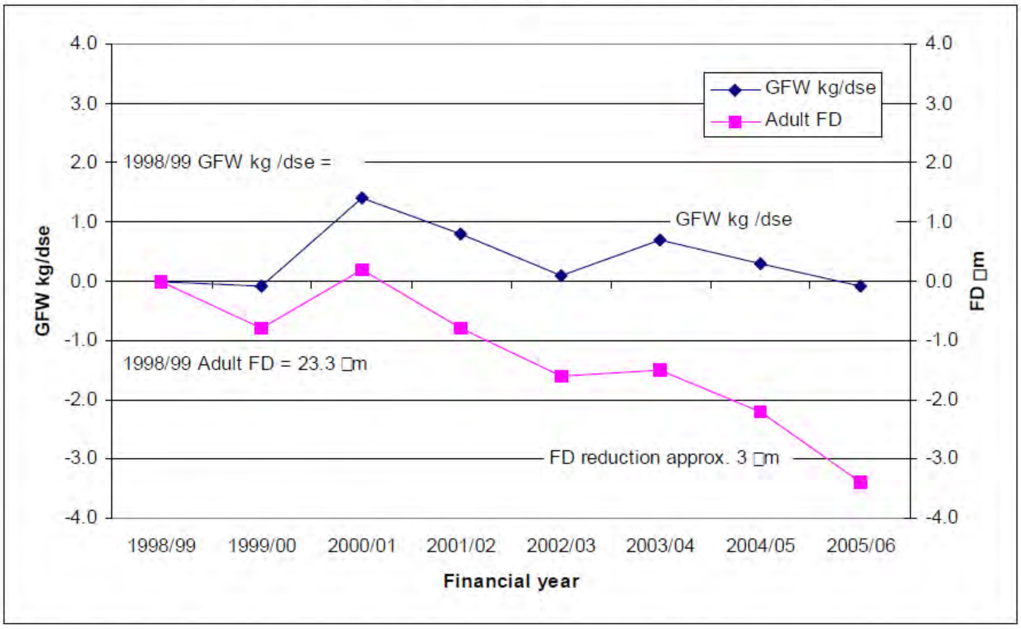
Results

Turkey Lane flock ewes were joined to rams bred in the nucleus. Although there was a radical shift in the performance of the rams mated, the production at the flock level was held back by the production of older base ewes bred from previous matings. These ewes were also having a genetic effect on the performance of the progeny being bred in the early 2000s, both in the nucleus and in the flock. In 2003 as the number of base ewes started to reduce and the improved genetics contributed more significantly to the flock's production, a significant change in the flock's production starts to take place.

Figure 2 describes the actual production of the flock and is therefore affected by seasonal conditions. For example, 2000/01 was an excellent season but 2005/06 had the worst start in 30 years. The proof that the breeding system is working is that the outcome in 2006 is very much in line with direction and magnitude planned in 2000. The effect on profit of the commercial flock is very significant. Based on March 2006 prices the reduction of 3 microns fibre diameter while maintaining fleece weight has resulted in an 18% increase in income. Based on market values of any 5-year period in the 20 years preceding the objective being set, the increase in profits would have exceeded 50%. The change in flock performance and profit will continue to grow as the introduced genetics flow through into the flock and the effect of the base genetics is effectively eliminated.

- Achieved by 2006:
  - 50kgs GFW per hectare,
  - 20 micron wool,
  - at least $300.00 gross sheep income per hectare,
  - Extra Income/year – $29,062.00,

Figure 2. *Turkey Lane* flock production deviation from the 1998/99 base for Greasy Fleece Weight (GFW%) and Fibre Diameter (FD µm) resulting from the genetic change introduced through a ram-breeding nucleus.*



Number	41
Name	**Merino Wether Challenge**
Traits researched	CFW, FD, WT, EMD, carcase measurements
Date	2007
Target audience	Ram breeders and buyers
Target	Wool and Meat
Source	AWI, Angus Beveridge
Contact	Angus Beveridge, Ph: 02 6848 5838 E: angus.melinda@bigpond.com

Further Information

Permission	Yes
Summary of resources	Report to AWI Summary of results inserted into this document
File and format	**41a** WP067 - Report - 2007 Merino Wether Lamb Challenge - Dubbo National Ram Sale Association.pdf

Key facts

- 34 teams of wethers entered into a wool and carcase challenge.
- Domestic and export class.
- A demonstration not a scientific trial.

Note

- Ewe trials, wether trials and sheep productivity trials emphasise a large variation in the genetic performance between animals. Superior performance in these trials is at times attributed to the incorporation of advanced genetic technologies like breeding values and indexes or the inclusion of objective measurement in selection programs. They also stress the need to use tools that describe genetic differences when making ram and sire choices.

Useful info

- 32 teams of 3 wethers in final results – mixture of stud and commercial entries.
- Teams made up of 5 per team with end result involving the best 3.
- Source from property and into a feedlot for 10 weeks.
- Processed by Fletchers international, market prices of 20-26kg $2.00/kg, <20kg and <,30kg $1.80/kg, >30kg $1.50/kg.
- Lanoc Wool provided fleece values based on 2007 market prices.

Background

The aim of this work was to raise awareness of the value of the Merino wether lamb.

- To encourage discussion about the advantages of finishing a Merino wether lamb.
- To raise awareness of getting the genetics and management right to maximise returns.

Results

Carcase results summary:

	Start Kg	End Kg	Ave Daily Growth Rate	Hot Carcase Kg	Carc. $
Top team	63.7	86.2	313	40	64.00
Bottom team	27.7	42.8	211	16.8	23.52
Average	**44.2**	**62.4**	**252.4**	**26.9**	**48.4**

Fleece results summary:

	GFW	FD	SD	CV	Comf	CURV	Wool $
Top team	6.8	18.2	3.4	15.6	99.2	83.4	**43.67**
Bottom team	1.4	19.2	3	18.7	99.7	72.6	**4.95**
Average	**4.1**	**18.7**	**3.2**	**17.2**	**99.4**	**78.0**	**24.3**

Number	42
Name	**CSIRO Fine Wool Project**
Traits researched	FD, CFW, SL, SS, subjective assessment, crimp frequency, style, skin, processing performance, feed efficiency and disease resistance
Date	1990 -2000
Target audience	Ram breeders and ram buyers
Target	Wool
Source	CSIRO
Contact	Dr Ian Purvis, CSIRO, Ph: 02 6776 1373 E: Ian.Purvis@csiro.au

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	Proceedings of fine wool symposium – a number of papers Genetic parameter paper Fine wool project newsletters
File and format	**42a** Swan, A.A., Piper, L.R. and Purivs, I.W. (2000) In "Finewool 2000 – Breeding for Customer Needs", Eds. A.A. Swan and L.R. Piper, CSIRO and The Woolmark Company. Finewool2000.pdf **42b** Parameters Swan, A., Purvis, I. and Piper, L. (2008) Genetic parameters for yearling wool production, wool quality and bodyweight traits in fine wool Merino sheep. *Australian Journal of Experimental Agriculture, 2008,* ***48****, 1168–1176* swan_etal_ajea_2008.pdf **42c** project newsletters FinewoolNews.pdf **42d** Smith Crimp Frequency work Smith, J.L. and Purvis, I.W. (2003) Breeding Strategies to Meet the Specifications of Fine Wool Markets. *Proc. Adv. Anim. Breed.Gen. (2003) 15.* smith paper aaabg 281-285.pdf

Key Findings

- This was an historic project that aimed to support the fine and superfine wool industries.
- It developed a robust dataset for the estimation of fine wool parameters.

- These parameters were used to estimate selection outcomes based on a range of indices.
- The project encompassed a range of work outlined in ***ref 42a*** and produced related work such as:
    - The genetics of skin follicle populations.
    - Early-stage wool processing research.
    - PhD research looking at the role of crimp frequency in ultrafine wool selection programs.
- The project developed other advancements in the measurement and processing of fine wools.
- The T13 project saw the realisation of the outcomes generated from this project.

Useful Information

- The project was run at CSIRO in Armidale, NSW.
- There were contributions from industry of 9 fine wool bloodlines and 2 medium wool bloodlines. The medium wool bloodlines provided a link to previous and current research.
- Ewes were mated within bloodline to sires purchased each year from the bloodline, with linkage maintained across years.
- 6 fine wool sires were entered into Central Test Sire Evaluation to provide industry links and benchmarks. These were not identified for each bloodline.
- An offshoot of the project was the assessment of fine wool bloodlines in traditionally medium wool environments (Condobolin, NSW and Katanning WA).
- A number of research projects were associated with the Fine Wool Flock with some of those reported in ***ref 42a***.
- Economic performance was based on auction sale data derived from the New England Wool Statistical Area over the years 1997-1998 to 1999-2000 applying the Merino Bloodline Package methodology for calculating GM/DSE.
- The project allowed for related research in skin and crimp frequency, of which some is reported in ***ref 42a*** and ***ref 42d***.

Background

Fine Wool Project - Objectives

1. To establish 11 Merino breeding flocks representative of current industry genotypes within the 17-22 micron range of average adult fibre diameter.
2. To collaborate with CSIRO Textile and Fibre Technology (CTFT) in research programs aimed at developing improved methodologies for objective specification of fibre diameter, staple length, staple strength, colour, resistance to compression, and style.
3. To undertake the measurement program required to estimate genetic and phenotypic parameters as well as economic values for lifetime wool production, wool quality and processing performance traits in fine wool genotypes.
4. To conduct collaborative research with CTFT on the processing performance of fine wools and on the quality of the resulting fabrics.
5. To conduct collaborative research with NSW Agriculture and Agriculture WA on wool production, wool quality and processing.

Results

Ref 42b

Table 5. Estimates of phenotypic variances, and heritabilities from this study (Fine Wool Project) compared with literature averages from the reviews of Fogarty (1995) and Safari *et al.* (2005) and estimates from Safari *et al.* (2007*a*) and Wuliji *et al.* (2001) (± s.e.)

See Table 1 for trait definitions. Genetic correlations between direct genetic effects of traits are shown in the lower part of the table, along with phenotypic correlations in the upper part of the table. Variances and heritabilities estimates have been averaged across multivariate analyses, while correlations have been obtained from the analyses described by Table 2

Trait	ygfw	ysfw	ycfw	yyld	yfd	yfdcv	yss	ysl	wwt	ywt
					Phenotypic variances					
	0.09 ± 0.002	0.06 ± 0.001	0.06 ± 0.001	14.60 ± 0.35	1.09 ± 0.02	4.65 ± 0.08	82.82 ± 1.76	68.95 ± 1.59	5.65 ± 0.10	9.78 ± 0.19
					Heritabilities					
Fine Wool Project	0.40 ± 0.03	0.49 ± 0.05	0.37 ± 0.04	0.60 ± 0.03	0.66 ± 0.02	0.46 ± 0.02	0.34 ± 0.03	0.54 ± 0.03	0.20 ± 0.02	0.51 ± 0.04
Fogarty (1995)	0.34	–	0.37	–	0.51	–	–	–	0.33	0.57
Safari *et al.* (2005)	0.37	–	0.36	0.56	0.59	0.52	0.34	0.46	0.23	0.41
Safari *et al.* (2007*a*)	0.46	–	0.42	0.47	0.68	0.57	–	–	0.29	0.36
Wuliji *et al.* (2001)	0.24	–	0.28	0.58	0.59	0.69	0.13	0.71	0.34	0.43
					Genetic and phenotypic correlations					
ygfw	–	0.80 ± 0.02	0.84 ± 0.02	0.04 ± 0.02	0.29 ± 0.01	–0.09 ± 0.01	0.14 ± 0.02	0.28 ± 0.02	0.49 ± 0.02	0.46 ± 0.02
ysfw	0.88 ± 0.02	–	0.68 ± 0.03	0.04 ± 0.02	0.34 ± 0.02	–0.09 ± 0.02	0.18 ± 0.02	0.22 ± 0.02	0.50 ± 0.02	0.42 ± 0.02
ycfw	0.90 ± 0.01	0.87 ± 0.03	–	0.37 ± 0.02	0.22 ± 0.02	–0.12 ± 0.02	0.19 ± 0.02	0.37 ± 0.02	0.50 ± 0.02	0.42 ± 0.02
yyld	–0.15 ± 0.07	0.00 ± 0.10	0.28 ± 0.07	–	–0.00 ± 0.02	–0.17 ± 0.02	0.22 ± 0.01	0.32 ± 0.01	0.14 ± 0.02	0.05 ± 0.02
yfd	0.25 ± 0.05	0.30 ± 0.06	0.15 ± 0.06	–0.01 ± 0.04	–	–0.13 ± 0.01	0.16 ± 0.01	0.16 ± 0.02	0.14 ± 0.02	0.24 ± 0.02
yfdcv	0.06 ± 0.06	0.13 ± 0.07	0.00 ± 0.07	–0.21 ± 0.05	–0.18 ± 0.04	–	–0.37 ± 0.01	–0.13 ± 0.02	–0.15 ± 0.02	–0.20 ± 0.01
yss	0.02 ± 0.08	0.01 ± 0.10	0.14 ± 0.08	0.38 ± 0.05	0.26 ± 0.05	–0.59 ± 0.04	–	–0.04 ± 0.02	0.15 ± 0.02	0.03 ± 0.02
ysl	0.29 ± 0.07	0.35 ± 0.10	0.38 ± 0.07	0.29 ± 0.05	0.13 ± 0.04	–0.09 ± 0.05	–0.15 ± 0.06	–	0.10 ± 0.02	0.19 ± 0.02
wwt	0.33 ± 0.07	0.46 ± 0.07	0.45 ± 0.07	0.09 ± 0.09	0.19 ± 0.06	–0.12 ± 0.07	0.05 ± 0.09	0.33 ± 0.08	–	0.73 ± 0.01
ywt	0.25 ± 0.06	0.27 ± 0.07	0.23 ± 0.08	–0.00 ± 0.07	0.20 ± 0.05	–0.25 ± 0.05	–0.17 ± 0.07	0.26 ± 0.07	0.61 ± 0.05	–

Ref 42a page 9

The fine wool flock demonstrated that, despite strong industry perceptions at the beginning of the project, it is possible simultaneously to reduce fibre diameter and increase fleece weight in fine wool bloodlines. The following predictions are based on within-flock selection and response rates represent the upper limits of what can be achieved in practice once selection for visual attributes is considered. These predictions went on to be successfully validated in the T13 flock.

Table 5: Predicted trait changes after 10 years of selection using hogget measurements of clean fleece weight (CFW), mean fibre diameter (MFD), and body weight (BWT). Staple strength abbreviated as SSTREN.

Micron	CFW (Kg)		MFD (micron)		SSTREN (N/Ktex)		BWT (Kg)	
Premium	*Hogget*	*Adult*	*Hogget*	*Adult*	*Hogget*	*Adult*	*Hogget*	*Adult*
3%	0.4	0.3	-1.4	-1.5	-3	-7	5	3
15%	0.2	0.1	-3.6	-3.6	-7	-9	2	1
30%	0.1	0.0	-3.9	-3.9	-7	-8	0	1

The predictions are then adjusted for when staple strength is added to the breeding objective.

Table 6: Predicted trait changes after 10 years of selection using hogget measurements of CFW, MFD, CVFD, and BWT with staple strength added to the breeding objective

Micron	Strength	CFW (Kg)		MFD (micron)		SSTREN (N/Ktex)	
premium	premium	*Hogget*	*Adult*	*Hogget*	*Adult*	*Hogget*	*Adult*
3%	*1%*	0.4	0.3	-0.4	-0.6	3	-1
15%	*3%*	0.1	0.0	-2.7	-2.9	3	0
30%	*5%*	0.0	-0.1	-3.2	-3.3	1	0

Ref 42a page 3

While this was not the function of the Fine Wool Project, the comparative performance of the bloodlines under a standard set of environmental conditions was of interest. The between-bloodline variation in MFD (fibre diameter) proved to be less and the variation in CFW (clean fleece weight) perhaps more than expected. There was considerable variation between bloodlines in GM/DSE, as has been found in other Merino bloodline analyses. The vast majority (>90%) of that variation was accounted for by variation between bloodlines in CFW and MFD. Surprisingly, at the fine end of the clip, variation between bloodlines in style contributed very little to the variation in GM/DSE.

Table 2. Clean fleece weight, mean fibre diameter and estimated gross margin /dse for hogget and adults in each of the eleven bloodlines

Bloodline	Hogget			Adult		
	cfw (kg)	Mfd (micron)	gm/dse ($)	cfw (kg)	mfd (micron)	gm/dse ($)
1	1.49	16.8	31.3	2.23	17.6	30.0
2	1.78	17.1	36.5	2.85	18.3	29.8
3	1.81	17.0	38.3	2.96	18.1	36.7
4	1.61	16.7	35.1	2.57	17.6	35.4
5	1.55	16.7	33.4	2.20	17.6	30.3
6	2.20	18.0	33.6	3.91	20.0	21.8
7	1.38	16.9	24.1	2.02	17.9	23.4
8	1.98	18.9	17.5	3.38	20.7	14.8
9	1.52	17.0	29.0	2.29	18.3	23.6
10	1.49	16.9	29.6	2.32	17.7	31.0
11	1.35	17.0	23.1	2.06	17.9	24.1
Mean	1.65	17.2	30.1	2.62	18.3	27.4

***Ref* 42d**

Smith and Purvis examined breeding strategies designed to meet the specifications of fine wool markets and examined the inclusion of crimp frequency as a trait for consideration in fine wool breeding objectives. Smith predicted the outcome of including crimp frequency in fine wool breeding objectives. The following parameters were used for the prediction – where cf is crimp frequency:

Table 1. Phenotypic variance (V_p), heritability (h^2), phenotypic (r_p) and genetic (r_g) correlations of traits included in response predictions to selection.

	hgfw	agfw	hcfw	acfw	hmfd	amfd	hcvd	acvd	hss	ass	hsl	asl	hcf	acf
V_p	0.09	0.19	0.06	0.12	1.11	1.32	4.89	3.77	85.64	78.09	70.04	64.79	0.44	0.56
h^2	0.44	0.43	0.42	0.40	0.65	0.67	0.45	0.46	0.35	0.33	0.53	0.53	0.34	0.40
r_p hsl x	0.29	0.14	0.39	0.25	0.15	0.04	-0.11	-0.06	-0.04	0.01	1.00	0.60	-0.27	-0.14
r_g hsl x	0.27	0.17	0.42	0.33	0.10	-0.01	-0.05	-0.02	-0.12	0.09	1.00	0.88	-0.39	-0.20
r_p hcf x	-0.10	-0.05	-0.16	-0.08	0.10	0.05	-0.03	0.00	0.02	0.00	-0.27	-0.14	1.00	0.60
r_g hcf x	-0.18	-0.09	-0.29	-0.15	0.09	0.05	-0.01	0.00	-0.14	-0.07	-0.39	-0.20	1.00	0.70

Standard errors for phenotypic correlations <0.02 and for genetic correlations from 0.06 – 0.10.

The predicted outcomes are set out in Table 2:

Table 2. Predicted response in economically important fleece traits for three breeding objectives and for different sets of selection criteria.

Selection criteria					Predicted response per 10 years of selection												
cfw	mfd	cvd	cf	sl	gain	hcfw	acfw	hmfd	amfd	hcvd	acvd	hss	ass	hsl	asl	hcf	acf
Base breeding objective: increase cfw, decrease mfd, maintain ss																	
✓	✓	✓			29.50	0.03	0.05	-2.15	-2.29	-1.99	-1.87	0.53	0.20	0.36	2.25	-0.16	-0.11
1. Maintain high cf + increase cfw, decrease mfd, maintain ss																	
✓	✓	✓	✓		28.59	-0.02	-0.08	-2.11	-2.27	-2.10	-1.94	1.64	0.41	-0.95	1.59	0.00	0.03
2. Low cf, long sl + increase cfw, decrease mfd, maintain ss																	
✓	✓	✓	✓		35.10	0.12	0.03	-1.78	-1.87	-1.88	-1.75	3.02	0.72	3.46	3.64	-0.53	-0.43
✓	✓	✓	✓	✓	38.84	0.12	0.07	-1.65	-1.89	-1.66	-1.50	0.74	-0.26	10.38	9.86	-0.56	-0.41
3. High cf, long sl + increase cfw, decrease mfd, maintain ss																	
✓	✓	✓	✓		29.86	0.04	-0.04	-1.94	-2.10	-2.21	-2.03	2.30	0.50	0.12	2.26	-0.04	0.00
✓	✓	✓	✓	✓	33.34	0.05	0.02	-1.79	-2.08	-1.94	-1.73	0.00	-0.49	7.65	8.85	-0.11	-0.03

Discussion is provided in 42d. The conclusion was that, without making direct comparisons of economic gains, this study demonstrates that acceptable trait gains can be made under all three breeding objectives. However, it also illustrates that the rewards need to be significant in order to meet breeding objectives where antagonistic relationships between the traits are involved.

Number	43
Name	**Hillcott Grove - Bloodline Comparison**
Traits researched	CFW, FD, WT, fleece value, carcase value
Date	2003
Target audience	Ram breeders and buyers
Target	Meat, Wool and Maternal
Source	Department of Primary Industries and Resources of South Australia, Glen Tilley
Contact	Glen Tilley, M: 0409 140 592
What's missing	Only one year of analysis – so not as robust as could be

Further Information

Permission	Yes
Summary of resources	Article provided by Bruce Hancock
File and format	**43a** Tilley on-farm comparison.pdf

Key Findings

- EBV differences were compared in an on-farm trial conducted with two Merino strains, with strains performing as predicted.

Useful Information

- Original EBV differences were derived from a number of sources at the time of the trial - one central genetic evaluation process was not available.
- The project involved on-farm bloodline comparison.
- Rams were of equal financial value and of average genetics for each bloodline.
- Ewes lambed in July- August 2002 and were shorn in April 2003.
- Ewes ran together at all times except for lambing. The lambs were shorn in June 2003 and the wethers sold in August 2003.
- Actual prices received for wool and carcase were used for comparison (clean price fleece values: Strain A $6.20; Strain B $6.05) (Carcase: strain A $3.12/kg; Strain B $3.29/kg).

Background

Glen Tilley of "Hillcott Grove", Tarlee SA, is already reaping rewards from investing in Merino genetics with enhanced fertility. Breeding objectives include "highly fertile Merino ewes producing well-muscled lamb carcase and growing quality fine-medium wool".

A focus was maintained on the breeding objective, the genetics to support it which have EBV data as evidence, and the monitoring of profit through gross margins, stocking rate and production per hectare of meat and wool.

In 2001, Glen set some challenging targets for his 1000 hectare mixed farming operation, but the results below would indicate that he is well on the way.

	01/02	**02/03**	**04/05**
Stocking rate (DSE/ha)	6.1	5.7	7.0
Weaning%	94	100	111
Wool cut (kg) /ha	27	22(1)	35
Micron	21.7	20.1	20.0
Liveweight Production (kg) /ha	92	101	110

(1) – Dry season, old ewes and lighter Merino lambs contributed to the lower cut.

Although Estimated Breeding Values (EBVs), sire reference data, Merino Genetic Services and commercial on-farm performance all indicated the strain of ewes and rams would increase fertility, Glen was keen to conduct his own "on-farm progeny test" to ensure that EBVs also worked for him.

Results

The results from the 2003 drop progeny (wool and wether carcase) and ewes (wool and lambing%) have given a $28.90 per ewe difference – a figure well worth evaluating further.

The weaners were sold as lambs 13-14.5 months old. They were sold in 3 lots. Lots 1 & 3 were sold over the hook. Lot 2 was sold at Dublin saleyards.

The Strain B lambs were earlier maturing with 46.5% going into the 1st draft compared to 24.5% of the Strain A. In the final draft, there were still about 10% plain Strain A lambs, and only 2% of Strain B.

Selling the lambs over the hook resulted in a higher price per kilo for the Strain B lambs as more lambs were in the heavier weight categories.

	Strain A	**Strain B**
Ewe Origin	Bred on farm for last 4 years	Mature age ewes bought in
	Mixed age to 4 y.o (lambing % adjusted for 25% maidens)	7 y.o (Struggled under tight feed conditions)
Weaner wool (11mo)		
GFW (kg)	4.15	3.84
Micron	18.1	17.6
Fleece value	$25.82	$23.17
Weaner meat (13mo)		
Carcase weight (kg)	19.49	19.93
Carcase price ($/kg)	$3.12	$3.29
Carcase value	$64.50	$70.14
Return per ewe		
Lambing %	100	135* *unusual result*
Wool value	$34.30	$27.45
Lamb value	$90.32	$125.97
TOTAL	$124.52	$153.42
Balance in favour		$28.90

This is only one year of data and Glen suggests that the increase in reproduction rate of 35% was unusual and 15% would have been more realistic.

Other SA producers have used Strain B rams over their current ewe flock and recorded increases in reproduction in the first crossing. It would appear one doesn't have to wait until the desired genes are all through the ewe flock to get an impact.

Given the current lower wool demand and the strength in sheepmeat and breeding ewes (ie carcase weight and numbers); the traditional “profit drivers” in cereal zone, self-replacing Merino flocks continue to be challenged.

Stocking rate is still king, but if total lamb carcase weight per Merino ewe can be increased by 20-30% by selecting different rams, then its worthy of asking the seedstock producer for EBVs on number of lambs weaned (NLW) and growth (PWT), as well as the normal wool traits.

Number	44
Name	**The South Roxby Project / World's Finest Ram Project**
Traits researched	Wool traits
Date	1998 - 2002
Target audience	Ram buyers
Target	Wool
Source	Mackinnon Project, Vizard Foundation and AWI
Contact	Dr John Larsen, Mackinnon Project E j.larsen@unimelb.edu.au
What's missing	**Could ask John Webb Ware for production data for one of the clients to determine whether the outcomes were realised.**

Further Information

Permission	Papers are available by accessing http://sheepjournal.net/
Summary of resources	Two papers
File and format	**Ref 44a *(not provided)*** Larsen et al (2002). Linking Australian woolgrowers with research: The South Roxby Project. *Wool Technology and Sheep Breeding; Vol 50, No 3 (2002).* http://sheepjournal.net/ **Ref 44b *(not provided)*** Hygate, L. (2002). Improving profitability of Merino properties through the rational use of artificial insemination and objective measurement in sheep selection. *Wool Technology and Sheep Breeding; Vol 50, No 3 (2002).* http://sheepjournal.net/

Key Findings

- The South Roxby Project as a model of participatory research saw the adoption of objective measurement by 50% of group participants (100 participants).
- Mackinnon staff worked with individual flocks to determine the most cost effective approach to genetic gains at the commercial level.

Background

The South Roxby Project is a research, demonstration and educational project for wool production systems in the high-rainfall zone of south-eastern Australia. The need for the project was identified by the failure of many Australian woolgrowers to adopt simple yet cost-effective strategies generated by over 40 years of agricultural research. A model of “participatory research”, involving producers, consultants and researchers in the identification of industry problems and research priorities, generated a portfolio of highly relevant new research.

This was integrated with an educational program, based on experiential learning and group theory, to present the results of past and recent research in a “whole-farm” context. Many participants also accessed the farm consultants facilitating the group activities on a one-to-one basis. This was critical to the learning process, enabling producers to move from an “awareness” of research findings and increased knowledge of the “profit drivers” for their businesses, generated by the group activities, to the appropriate adoption of technologies on their own farms. High adoption rates were achieved for specific technologies, including price-risk management, worm control and genetic improvement. After 4 years, 50% of participants were using objective measurement and quantitative genetics. This is a significant finding, as historically it has been very difficult to convince Australian woolgrowers of the merits of this technology. A demonstrated improvement in the profitability of a sample of farms provided further support for the positive impact of the project.

Results

Ref 44a

The following extract focuses on genetic outcomes from the project.

Since joining the project, one-third of participants (24 of 72) have embarked on a program of significant genetic improvement within their flocks by:

- Evaluating different bloodlines on their farm through progeny evaluation trials (7 flocks);
- Changing to finer or more productive bloodlines (9 flocks); or
- Breeding their own rams, based on index selection, BLUP analysis and use of semen from superior progeny tested rams selected from either Merino Benchmark or the Central Test Sire Evaluation (8 flocks).

At the sheep-breeding workshops, participants compared the visual examination of fleeces with objective data collected during a progeny evaluation trial at “South Roxby”. They also saw a powerful demonstration of the profitable impact of a successful breeding program, using objective measurement and quantitative genetics, in Wool Industry Science & Technology Conference 2002 data from the neighbouring “Roxby Park” flock (Webb Ware 2001). As with most farmer extension projects, it is difficult definitively to attribute changes on participants’ farms to any single factor but it is likely that participants were influenced by a combination of the South Roxby Project workshops, detailed one-to-one discussions with Mackinnon Project consultants and the sustained price premiums for finer wool.

Thirteen flocks were already using proven superior bloodlines and/or selection based on objective measurement when they joined the project. Thus, 50% of the participating farms were accessing breeding technologies with demonstrated high returns for the wool industry after 4 years. Over the next 10 years, these flocks should increase their average adult clean fleece weights from 4.6 to 5.1kg, while at the same time reduce average fibre diameter from 20µm to 18.1µm. At an average flock size of 8,000 sheep, the increased annual production after 10 years will be around 3,500kg per flock. The gross value of this increased production (at March 2002 wool prices of 800 and 1600c/kg respectively) is A$5.2 million.

Ref 44b

Linda Hygate, former Mackinnon project staffer, explored approaches to improving rates of genetic change at the commercial level via an open nucleus scheme as compared with the purchase of performance recorded rams. ***Ref 44b*** provides data for discussion around the use of these two approaches on the basis of the following results.

Table 2. The difference in performance between ram progeny born as a result of artificial insemination (AI) compared with natural mating (first joining only).

	GFW (kg)		FD (μm)		FDCV (%)	
Flock	AI	Natural	AI	Natural	AI	Natural
A	3.80 ± 0.06	3.46 ± 0.06	17.6 ± 0.1	17.0 ± 0.1	21.1 ± 0.3	21.5 ± 0.3
B	4.20 ± 0.06	4.16 ± 0.09	18.2 ± 0.1	18.7 ± 0.2	22.1 ± 0.2	22.6 ± 0.3
C	4.10 ± 0.07	3.94 ± 0.12	18.7 ± 0.2	19.6 ± 0.3	17.6 ± 0.2	18.5 ± 0.6
D	4.65 ± 0.08	4.48 ± 0.09	18.0 ± 0.2	18.4 ± 0.2	20.8 ± 0.3	19.8 ± 0.4
E	3.43 ± 0.10	3.05 ± 0.07	18.1 ± 0.1	18.6 ± 0.2	19.6 ± 0.2	19.4 ± 0.3
F	2.91 ± 0.08	2.44 ± 0.08	18.3 ± 0.1	18.1 ± 0.2	17.5 ± 0.3	18.4 ± 0.3

Table 3. The difference in performance between ram progeny born from sires purchased from a stud using performance recording compared with a stud not using performance recording.

	GFW (kg)		FD (μm)		FDCV (%)	
Origin of rams	Performance recorded	Non-performance recorded	Performance recorded	Non-performance recorded	Performance recorded	Non-performance recorded
E	4.10 ± 0.14	4.11 ± 0.09	18.1 ± 0.2	18.9 ± 0.2	19.2 ± 0.5	19.5 ± 0.3
F	2.46 ± 0.11	2.57 ± 0.08	17.3 ± 0.3	18.2 ± 0.2	17.7 ± 0.4	18.5 ± 0.5

Number	45
Name	**Merino Weaner Growth Paths Affects Prime Lamb Production**
Traits researched	PWT, HCWT, FD, CFW,
Date	September 2003 and June 2007
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	SARDI, MLA, AWI, SASMB
Contact	Dr Janelle Hocking Edwards SARDI, Struan, SA P 08 8762 9186 E: janelle.edwards@sa.gov.au
What's missing	Generation of the following charts would be helpful - Merino EBV versus carcase performance - Poll Dorset EBV versus performance

Further Information

Permission	Yes Please cite the journal source when using in future publications.
Summary of resources	Final report AAABG paper
File and format	**45a** *Final Report* Merino growth paths.pdf **45b** *AAABG Paper* Hocking Edwards, J., Starbuck, T.M., (2007) Liveweight and Wool Production Estimated Breeding Values are not Affected by Post Weaning Growth Path. *Proc. Assoc. Advmt. Anim. Breed. Genet. 17: 252-255* hocking_edwards252.pdf **45c** *Powerpoint presentation* HockingEdwards AAABG 2007 ppt.pdf

Key Findings

- The aim was to provide prime lamb producers with information to help them manage and optimise Merino genetics in prime lamb production system with a focus on the effect of GxE interactions.
- There are no GxE interactions in liveweight and carcase traits. Merino EBVs can be used to compare the genetic potential of Merino weaners that have undergone different post weaning growth paths.
- Prime lamb producers can use Merino EBVs with confidence to improve liveweight and carcase weight in their terminal cross lambs.
- Increasing post weaning growth paths of Merino ewes could possibly contribute an extra 10% more lambs per year per flock.

Useful Information

- Ewe progeny from 13 Merino rams followed two nutritionally different post weaning growth paths. The groups were randomly split at 12 weeks of age into a rapid growth weaner group (n=446 were supplemented to reach 40kg at 300 days) and normal growth weaners group (n=688 to reach 31kg at 300 days of age.
- Difference in liveweight was maintained through winter when both groups were run on similar pasture. During spring, there was compensatory growth in the normal group but a 7kg difference remained at hogget shearing.
- Wether weaners from a subset of Merino sires (6 rams) were also split into two groups at weaning.
- EBVS of Merino rams calculated by a predecessor of MERINOSELECT with extremely high accuracy sires used - all with over 74 progeny.

Background

The aim of this project was to investigate whether different post weaning growth paths affect the expression of genes in progeny from divergent Merino genetics and demonstrate whether these growth paths affect the EBVs for growth and wool production in Merinos. This project is part of a larger project to identify the influence of post weaning environment on the expression of Merino genes in prime lamb production systems.

Results

The post weaning path affects post weaning weight, hogget greasy fleece weight and hogget fibre diameter but EBVs for Merino PWT, HCWT and HFD will be comparable regardless of the post weaning growth path that the Merino lambs follow. The results suggest that MERINOSELECT is able to remove the effect of the environment from the phenotypic measurements of sheep and allow comparisons between sheep regardless of the environment in which they were raised.

Ref 45a

Table 8. Mean (±SEM) fleece characteristics of progeny groups from 13 Merino sires. Weaners were grown under normal or rapid post weaning growth paths. CFW - clean fleece weight (kg); FD – fibre diameter (um); H – hogget; A - adult.

	HCFW		HFD		ACFW	AFD
Merino ram	**Rapid**	**Normal**	**Rapid**	**Normal**		
Ram 1	3.82 ± 0.074	2.90 ± 0.077	18.1 ± 0.15	16.9 ± 0.16	3.24 ± 0.070	19.2 ± 0.18
Ram 2	3.90 ± 0.066	2.90 ± 0.069	18.5 ± 0.14	17.1 ± 0.14	3.19 ± 0.058	19.4 ± 0.15
Ram 8	4.07 ± 0.068	2.94 ± 0.068	17.6 ± 0.14	16.3 ± 0.14	3.30 ± 0.054	18.5 ± 0.14
Ram 5	4.14 ± 0.077	3.01 ± 0.071	18.8 ± 0.16	17.2 ± 0.15	3.60 ± 0.561	19.8 ± 0.14
Ram 7	4.22 ± 0.077	3.14 ± 0.064	18.9 ± 0.16	17.3 ± 0.13	3.40 ± 0.056	19.3 ± 0.14
Ram 13*	4.28 ± 0.119	3.15 ± 0.076	19.5 ± 0.25	18.0 ± 0.16		
Ram 6	4.31 ± 0.073	3.27 ± 0.076	19.8 ± 0.15	18.0 ± 0.16	3.43 ± 0.064	20.1 ± 0.16
Ram 3*	4.47 ± 0.126	3.19 ± 0.068	18.6 ± 0.26	17.5 ± 0.14		
Ram 11*	4.50 ± 0.116	3.08 ± 0.076	18.9 ± 0.24	17.1 ± 0.16		
Ram 9*	4.54 ± 0.096	3.49 ± 0.053	18.4 ± 0.20	17.2 ± 0.11		
Ram 10*	4.68 ± 0.126	3.11 ± 0.080	19.4 ± 0.26	17.4 ± 0.16		
Ram 4*	4.79 ± 0.139	3.59 ± 0.079	18.7 ± 0.29	17.2 ± 0.16		
Ram 12*	5.16 ± 0.134	3.46 ± 0.073	19.4 ± 0.28	17.9 ± 0.15		
Average	*4.38 ± 0.030*	*3.17 ± 0.020*	*18.8 ± 0.06*	*17.3 ± 0.04*		

Ref 45b

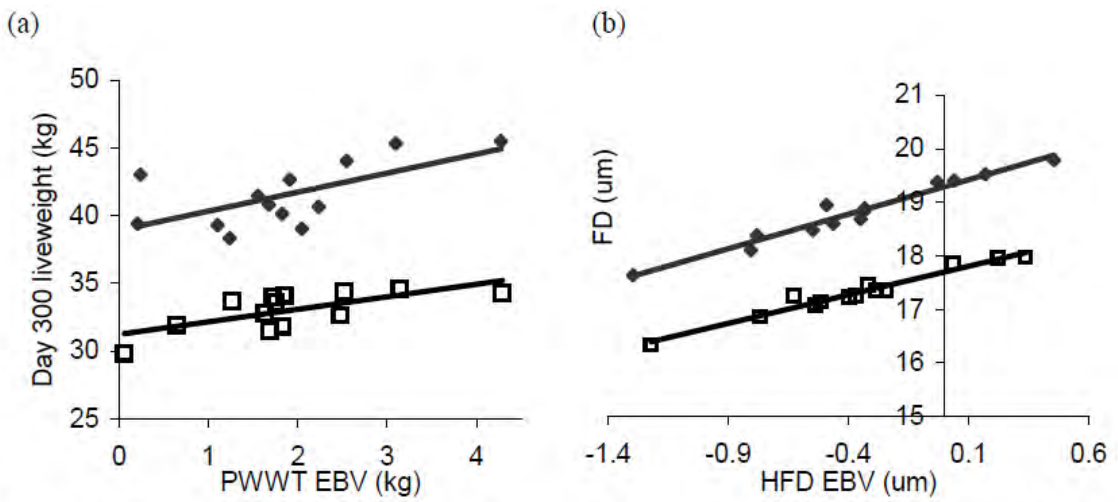


Figure 1. Regression of mean progeny group (a) liveweight at 300 days of ageand (b) fibre diameter (FD) on mean progeny group post weaning weight (PWWT) and fibre diameter (HFD) EBV of sheep on a rapid (closed diamonds) or normal (open squares) postweaning growth path

Ref 45a

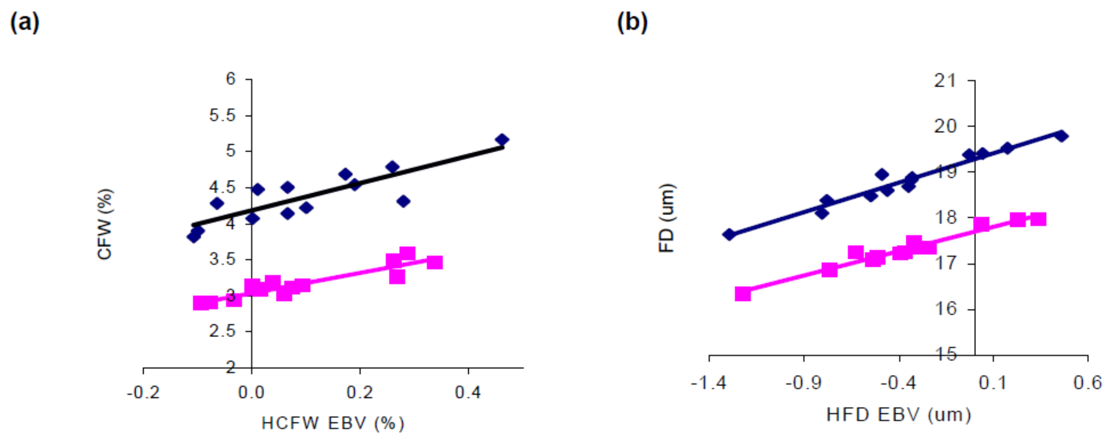


Figure 7. Regression of mean progeny group (a) hogget clean fleece weight and (b) fibre diameter (FD) on mean progeny group post weaning weight (PWWT) and fibre diameter (HFD) EBV of sheep on a rapid (blue diamonds) or normal (pink squares) post weaning growth path.

Number	46
Name	**SP Toolkit – What are the Benefits of Sheep Genetics**
Traits researched	
Date	2009
Target audience	Ram breeders and ram buyers
Target	Meat, Maternal and Wool
Source	AWI and MLA
Contact	Luke Stephen, MERINOSELECT, Ph: 02 6773 3191 E: lstephen@mla.com.au

Further Information

Permission	Yes
Summary of resources	Reference from Sheep Genetics Service Providers Toolkit
File and format	**46** SP Toolkit - What are the Benefits of Sheep Genetics 090709.pdf

What is Sheep Genetics and what are the Benefits of Sheep Genetics?

Sheep Genetics is the national genetic information and evaluation service for the meat and wool sectors of the sheep industry delivered as LAMBPLAN and MERINOSELECT.

Sheep Genetics produces a range of tools to assist with breeding and selection decisions. The core products are estimated breeding values and indexes, with additional services provided to facilitate the effective use of these tools and making them available to industry.

Estimated breeding values enable sheep breeders to compare the genetic merit of rams and ewes within designated groups, breeds or where appropriate between breeds. Estimated breeding values are able to be compared across flocks and years (benchmarked to industry), independent of the environment and when produced from Sheep Genetics are called Australian Sheep Breeding Values (ASBVs).

Sheep Genetics uses as much information as possible to generate ASBVs i.e. measured and scored data, sire and dam pedigree, the heritability of the trait, information from relatives, relationships between traits and any know non genetic influences.

ASBVs are predominantly available for objectively assessed characteristics but over time more visually assessed attributes will be available as ASBVs

Sheep Genetics provides many benefits to ram breeders and commercial ram buying clients. The benefits available to each of these groups are outlined below.

Benefits for Ram Breeders

Reduced risk through improved animal description and selection

- Improved rates of genetic progress by more accurately and reliably identifying genetic rankings and thus superior animals.
- Genetic progress in economically important traits without impacting on conformation attributes
- Enable genetic advancements in traits traditionally hard to visually evaluate:
  - Carcase
  - Parasite resistance – worm and fly
  - Staple Strength
- Obtain a genetic benchmark:
  - Know where your stud sits compared to ram breeding flocks across Australia
  - Introduce new genetics with increased confidence – without compromising your genetic position
- Monitor progress over time – genetic trends:
  - Using Breeding Values to monitor and demonstrate progress
  - Annual review of progress towards targets
- Predict genetic progress for the future.
- Assist with identifying traits that require improvement:
  - Fine tune selection decisions to maximise genetic potential in traits that make you money

Identify opportunities for sales and marketing

- Trait leaders are benchmarked nationally.
- Sales opportunities by listing breeding values on the Sheep Genetics website.
- Access to latest genetic advancements – gene markers.

Provide more accurate and reliable information to your clients

- Breeding values for a wide range of traits.
- Breeding values that can be compared across flocks or years.
- Demonstrate progress over time and predicted progress for the future.
- Indexes - make the selection process easier.

Reduce risks associated with important animal selection

- Select the right animals for high cost AI, JIVET, MOET, ET programs.
- Add value to raw data, fleece testing, carcase measurements, etc.

Benefits for Commercial Producers

Identify rams that are more likely to perform as expected

- Breeding Values are a valuable selection tool that more accurately predict the merit of major economic traits compared to raw measurements or visual appraisal.

Fast track genetic progress

- Accurately identify the most profitable genes according to their breeding goals.
- Faster progress towards defined market requirements will lead to improved profitability.

Access to tools to simplify the selection process

- Breeding values that can be accurately compared across flocks or years.
- Indexes – simplify selection by weighing up a number of traits.

- A range of indexes available that match broad industry objectives (dual purpose, fine, superfine, etc).
- A web search to compare and identify potential semen sires.

Monitor genetic progress

- MERINOSELECT genetic trends enable commercial breeders to review their ram sources genetic performance and ensure that breeding goals are achieved.
- Ensure commercial breeders goals are well matched to their ram seller.

One language

- Use of one language improves the ability of commercial producers to understand and use Breeding Values.

HISTORIC RESEARCH FLOCK SUMMARY

***Ref 47* – A Sheep CRC survey of historic genetic research flocks in the Australian sheep industry is included as *Ref 47*. Individual surveys outline the flock aims, structure, data captured and publications resulting from each flock.**

Research Flock	Dates	Aims	Organisation
South Australian Base Flocks	1988-1997	Estimate phenotypic and genetic parameters for wool production, wool quality, skin, reproductive and body characters of rams at 10 and 16 months and of ewes at 16 months and adult ages. Estimate the genetic association between wool production, wool quality, skin, body and reproductive characters of rams at 10 and 16 months, with lifetime wool production, quality and reproductive rate of breeding ewes. Assess the potential of novel skin characters as early indirect selection criteria for adult wool production and quality.	SARDI
Adapted Sheep Flock	1992-1994	Identify characteristics of sheep that are adapted to hot environments 1992-1994.	QDPI
Cape Borda		To compare the reproductive and productive performance of the ewe offspring of Booroola, ½ Booroola, AB20 and SA Merino (Collinsville) in an oestrogenic clover environment.	SARDI
Fowlers Gap-Selection Flocks	1984-?	Fowlers Gap - 3 flocks: a/ Control—Collinsville type selected for 20 years on a measurement basis—24 u--->100 % average marking since 1984. b/ Elite wool flock established in 2001/2002 with input of Elite sires from Pooginook and Toland. c/ Dohne flock established similar to [b] in 2001/2002 by use of 5 Dohne sires.	University of NSW
Haemonchus Worm Resistance selection	1978 – 2002	Three Fine Wool Merino lines, each comprising 100 breeding ewes, were established in 1977. Since then they have been maintained as self-replacing lines selected to study the direct and correlated responses to genetic selection for increased and decreased resistance of parasites. Line 1 IRH Increased resistance Haemonchus Line 2 DRH Decreased resistance Haemonchus Line 3 Random Control In 1986-1987 proof of concept established, it was apparent that lines had diverged.	CSIRO
Hamilton Worm Resistance Flock	1986-1992	Selection for resistance to intestinal parasites. This flock tested whether or not selection to intestinal parasites worked, and if selection on some kind of immunological	DPI Victoria

Research Flock	Dates	Aims	Organisation
		test would work.	
Hyfer development and Selection flock	1978 - 1996	A composite breed dam line was developed from matings of Booroola Merino and Trangie Fertility Merino rams to Dorset ewes with the progeny reciprocally crossed to form a base population of ½ Dorset, ¼ Booroola, ¼ Trangie Merino. This base was selected for total weight of lamb weaned per ewe joined in a fixed 8-monthly accelerated lambing system. A control flock was maintained.	NSW DPI
Katanning Base flocks	1982 - 1997	The Katanning Base flocks were established in 1982 by buying representative animals from the Collinsville, Bungaree and Peppin bloodlines. Each bloodline was represented by four studs. In 1996 four studs from the Performance Breeders were added.	DAFWA
Katanning Demonstration flocks (Wool, Meat and Staple strength)	1998 onwards	The Katanning Base flocks have been restructured in 1998 into these three flocks. Animals from the Base flocks have been randomly allocated to a wool, meat and control line. The wool line is currently selected to decrease fibre diameter while maintaining all the other traits, the meat line is selected to increase body weight and improve carcase traits while maintaining wool production traits. A random control line is kept.	DAFWA
Katanning Staple Strength flocks	1992 - ?	The Katanning Staple Strength flocks were established in 1992 by screening industry animals on high, low (tender) and average staple strength. In total approximately 12000 animals were screened. In 1998 the control and tender lines were discontinued. The aim was to study the underlying biological causes of staple strength.	DAFWA
Romney x Merino Mapping Reference Flock	1992-1997	In 1992 work commenced to establish a reference flock for ovine gene mapping by mating Romney Marsh rams to Merino ewes. From 1993 to 1997 matings continued to produce a full-sib and half-sib families.	CSIRO
CRC Meat Science Resource Flock	2003	Develop an understanding of the biochemical and physiological basis for the effects of genotypic and environmental factors (GxE) affecting muscle development and metabolism. Group — Ewe genotype (group size) — Sire genotype 1 — BL x M (120) — PD (sires selected for growth) x 4 sires 2 — M x M (120) — PD (sires selected for muscling) x 4 sires 3 — M x M (120) — PD (same 4 sires used in group1) 4 — M x M (120) — M x 4 sires 5 — M x BL (100) — BL x 4 sires	NSW DPI
Roxby Park Merino Stud	1993 – 2002	Aim: Selection for fine wool production. Selection criteria: 10% index (> 90% efficiency of selection on index)	Mackinnon Project

Research Flock	Dates	Aims	Organisation
South Australian Central Test Sire Evaluation	1995, 1996, 1998, 1999, 2001, 2002, 2003	Central Test Sire Evaluation (CTSE) compares the breeding performance of a sire by evaluating his progeny. CTSE has been designed to assess a sire's breeding performance for a large number of traits important to breeders. The South Australian CTSE was run on Rosebank Station, near Mount Pleasant in 1995 and 1996. The progeny from the 1998 & 1999 joinings were split between two SARDI research farms, "Struan" and "Turretfield". In 2001 the SA CTSE was expanded to evaluate, intestinal worm resistance, meat production and reproduction as well as the traditional wool measurements. Progeny from 2001 drop were assessed in 2 environments at both Struan & Turretfield.	SARDI
Short Tail flock	1988-1997	A recurring incidence of Merinos born with short tails was noted by a stud breeder in the mid-north of SA. Studies were conducted over 10 years (1988-97) to determine the mode of inheritance and determine the feasibility of breeding a genetically short tail flock	SARDI
South Roxby Sire Progeny Trial	1995 – 2002	Evaluation of superfine Merino rams	Mackinnon
Terminal Sire 1986-1989	1986-1989	First cross ewes (Border Leicester x Merino ewes) were mated to 133 different sires from 5 Poll Dorset, 1 White Suffolk, 1 Siromt, 2 Meridale, 4 Merino studs. Rams were used for one season only. Sire groups were selected to represent the production mean and variation of the stud they represented. Data from 3,500 progeny were analysed. Carcases were halved and one side divided into six primals and full dissection into bone, tissue and fat was conducted. Heritabilities and phenotypic and genetic correlations for all traits measured (>50) were published. Each year 32-35 rams were joined with separate flocks of 30 – 38 ewes allocated at random for mating each year. The same ewe flock was used throughout. Lambs were allotted at random within sex to low and high slaughter weight groups but grazed together. Allotted weight groups were divided by sex to give four groups, each slaughtered the day their mean liveweight reached 30 and 35 kg for low and high weight ewes and 35 and 45kg for low and high weight cryptorchids.	DPI Vic
Trangie C Flock	1984 - 1989 1990 - 1995	The project consisted of two phases. The aim of Phase I was to estimate the difference between crossbred and purebred Merinos for all production traits. This ‘apparent heterosis’ was to be estimated across all crosses, for between- and within-strain crosses, and for separate bloodlines. Also, the average contribution of each bloodline from additive and maternal effects was to be estimated. The aim of Phase II was to estimate a large range of between-bloodline genetic parameters that could be used	NSW DPI

Research Flock	Dates	Aims	Organisation
		to predict the likely consequences of any particular crossbreeding scenario. In particular, the design would attempt to estimate individual and maternal heterosis and individual and maternal recombination loss. Also, between-strains and bloodline specific parameters were to be estimated.	
Trangie D Flock	1975 - 1983	The D Flock was a resource population with the following aims. *To develop approaches to improve reproductive performance and resistance to fleece rot and body strike among Merino sheep (as stated for Project K/1/1065).* Objectives included: 1. To assess the variability that exists between Merino strains and bloodlines within strains for production characters (fleece and body traits), reproductive performance and susceptibility to fleece rot and body strike. 2. To estimate within-flock genetic parameters (heritabilities, and phenotypic and genetic correlations) for production characters. 3. To estimate genetic parameters for the components of reproductive performance in Merino sheep, including the identification of potential indirect selection criteria. Based on these parameters, breeding plans to improve flock reproductive performance will be developed. 4. To estimate genetic parameters for resistance to fleece rot and body strike and to develop breeding plans for the improvement of resistance within the Merino. 5. To examine the histological and histochemical basis for differences in susceptibility to fleece rot and blowfly strike in order to identify more efficient methods of improving resistance to these conditions in the Merino. *To assess body strike resistance as a breeding objective and to incorporate this objective into practical breeding plans (as stated for Project K/1/1096).* Objectives included: 1. To evaluate the economic importance of body strike to the Merino industry. 2. To evaluate the potential for genetic improvement through selection. 3. To evaluate different methods of selection. 4. To evaluate new indirect selection criteria. 5. To incorporate resistance into breeding plans through estimation of the necessary genetic parameters.	NSW DPI
R&S (Resistant and Susceptible lines)	1975 - 1979) and 24 years (1980 - 2003)	The original objectives for the lines included: 1. Demonstrate that resistance to fleece rot and body strike could be altered by selection. 2. Evaluate the correlated responses in all major production, quality and reproduction traits resulting from selection on resistance. 3. Evaluate the correlated responses in fleece, skin and immunological characteristics that are associated with resistance in order to identify alternative selection criteria. More recent additional objectives are to provide a resource population for the study of the physiological, immunological and inflammatory mechanisms underlying resistance to fleece rot and body strike and identification and/or verification of major gene effects on resistance to fleece rot and body strike.	NSW DPI

Research Flock	**Dates**	**Aims**	**Organisation**
Trichostrongylus Worm Resistance Selection		To breed lines of sheep having increased and decreased immunological resistance to Trichostrongylus colubriformis.	CSIRO

RELATED RESEARCH

Reference Provided

Genetic Parameter Estimate for Meat Traits in Merinos (*Ref 48*)

Hopkins, D., Safari, A., Greeff, J., Taylor, P. (2007) Genetic Parameter Estimate for Meat Traits in Merinos. NSW DPI. Meat and Livestock Australia funded project SHGEN.014/B.SGN.0014. www.mla.com.au (***Ref 48***).

Genetic Parameters for Visually Assessed Traits and their Relationship to Production in Merinos (Ref 49)

Mortimer S.I., Robinson D.L., Atkins K.D., Brien F.D., Swan A.A., Taylor P.J., Fogarty N.M. (2009) Genetic parameters for visually assessed traits and their relationships to wool production and liveweight in Australian Merino sheep. *Animal Production Science* **49**, 32–42. (***Ref 49***)

Sheep Breeding Beliefs – a Survey (*Ref 50*)

Kaine, G., Linehan, C. Rowbottom, B. (2006) Merino Wool Producers Beliefs about Sheep Breeding and Sire Selection. Vic DPI. Australian Wool Innovation funded project EC186. Summary (***Ref 50***).

Physical Reference Not Provided

Impact of genotype and breeding values on meat and eating quality, and production.

Hopkins, D.L., Stanley, D.F., Martin, L.C. and Gilmour, A.R. (2007). Genotype and age effects on sheep meat production. 1. Production and growth. *Australian Journal of Experimental Agriculture* **47,** 1119-1127.

Hopkins, D.L., Stanley, D.F., Martin, L.C., Toohey, E.S. and Gilmour, A.R. (2007). Genotype and age effects on sheep meat production. 3. Meat quality. *Australian Journal of Experimental Agriculture* **47,** 1155-1164.

Hopkins, D.L., Stanley, D.F., Toohey, E.S., Gardner, G.E., Pethick, D.W. and van de Ven, R. (2007). Sire and growth path effects on sheep meat production. 2. Meat and eating quality. *Australian Journal of Experimental Agriculture* **47,** 1219-1228.

Hopkins, D.L., Stanley, D.F., Martin, L.C., Ponnampalam, E.N. and van de Ven, R. (2007). Sire and growth path effects on sheep meat production. 1. Growth and carcass characteristics. *Australian Journal of Experimental Agriculture* **47,** 1208-1218.

Hopkins, D.L., Hegarty, R.S. and Farrell, T.C. (2005). Relationship between sire estimated breeding values and the meat and eating quality of meat from their progeny grown on two planes of nutrition. *Australian Journal of Experimental Agriculture* **45***,* 525-533.

Siddell, J. McLeod, B.M., Toohey, E.S., van de Ven, R. and Hopkins, D.L. (2012). Impact of sire breeding values for muscling on loin muscle. *Proceedings of the 29th Biennial Conference of the Australian Society of Animal Production (in press).*

Hopkins, D., Stanley, D., Martin, L., Gilmour, A. and van de Ven, R. (2006). Influence of sire growth estimated breeding value (EBV) on progeny growth. *Proceedings of the 2006 Agribusiness sheep updates,* pp. 23-25.

Stanley, D.F. Hopkins, D.L. Martin, L.C. and van de Ven, R. (2006). Influence of sire growth EBV on early lamb growth. *Australian Society of Animal Production 26th Biennial Conference,* (Short communication No. 87).

Stanley, D.F. Hopkins, D.L. Martin, L.C. and Gilmour A.R. (2006). Relationship between sire EBVs for weight and progeny weight for age. *Australian Society of Animal Production 26th Biennial Conference*, (Short communication No. 86).

Hopkins, D., Stanley, D., Suster, D., Ponnampalam, E., Kerr, M. and Martin, L. (2005). Relationship between sire EBV's and carcase and meat quality traits. *Proc. 51st International Congress of Meat Science and Technology,* Baltimore, USA, 1649-1653.

Fogarty, N.M., Gilmour, A.R., and Hopkins, D.L. (1997). The relationship of crossbred lamb growth and carcass traits with LAMBPLAN EBVS of sires. *Proc. 12th Aust. Assoc. Anim. Breeding and Genetics* **12**, 304-307.

GLOSSARY

Abbreviation	Definition
1^{st} X ewe/lamb	First Cross Ewe or Lamb. The first generation of ewes/lambs from parents of different breeds.
2ndX lambs	Second Cross Lambs. Generally the progeny of 1stXEwes joined to terminal sires.
A	Adult
AGBU	Animal Genetics Breeding Unit
AMLRDC	Australian Meat and Livestock Research and Development Corporation
AMSEA	Australian Merino Sire Evaluation Association
ASBV	Australian Sheep Breeding Value
AWI	Australian Wool Innovation
Breech traits	Breech Cover, Crutch Cover, Breech Wrinkle and Dag
BWT	Birth Weight (kg)
C site	45mm from centre of the spine at the $12/13^{th}$ rib where eye muscle and fat depth is measured by an accredited muscle and fat ultra sound scanner
Carcase Plus	The Carcase Plus Index. A desired gain index, based on post weaning weight, fat depth and eye muscle depth in a 60:20:20 ratio.
CEM	Coarse Edge Micron (um)
CFW	Clean Fleece Weight (kg)
Comf	Comfort Factor (%)
Conformation traits	Jaw, Feet and Legs, Shoulder/Back, Face Cover and Body Wrinkle
Cryptorchid	Testes forced into the abdominal cavity to remove reproductive capacity but retain good growth rates and lean carcases.
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTSE	Central Test Sire Evaluation
CURV	Fibre Curvature, expressed in degrees/mm
DAFWA	Department of Agriculture and Food Western Australia
DAG	Matted wool and faeces hanging from the rear end of a sheep
Dressing percentage	Dressing percentage is calculated by dividing the warm carcase weight by the shrunk live weight of the animal and expressing the result as a percentage.
DSE	Dry Sheep Equivalent
E	Early

Abbreviation	Definition
EBCOV	Early Breech Cover
EBRWR	Early Breech Wrinkle
EBV	Estimated Breeding Value
EMD	Eye Muscle Depth (mm)
EMW	Eye Muscle Width (mm)
FAT	Fat depth at a constant weight (mm)
Fat Score	Used with liveweight to estimate the yield of saleable meat (%) of young sheep being marketed for meat. Fat scores are related to 5 mm ranges in total tissue depth (fat and muscle) at the GR site over the 12th rib and their accuracy can be verified by comparing estimated values to measured tissue depth at the GR site on carcasses
FBV	Flock Breeding Value
FD	Fibre Diameter (um)
FDCV	Coefficient of Variation of Diameter (%)
FDSD	Standard Deviation of Fibre Diameter (um)
FEC	Faecal Egg Count (eggs/g)
Flc Value	Fleece Value
GFW	Greasy Fleece Weight (kg)
GR fat depth	Fat depth at the GR site (mm)
GR site	110mm from the centre of the spine at the last long rib
GxE	Genotype by Environment
H	Hogget
HSCW	Hot Slaughter Carcase Weight (kg)
LHPA	Livestock Health and Pest Authority
Link Sire	A sire that provides common genes between flocks or groups.
LWG	Live Weight Gain (kg)
M	Marking
mBCOV	Marking Breech Cover
mBRWR	Marking Breech Wrinkle
MCPT	Maternal Central Progeny Test
MFD	Mean Fibre Diameter (um)
MLA	Meat & Livestock Australia

Abbreviation	Definition
MMFS	Making More From Sheep
MSS	Merino Superior Sires
MVP	Merino Validation Project
NSW DPI	New South Wales Department of Primary Industries
OFDA	Optical Fibre Diameter Analyser
P	Post Weaning
$P < 0.05$	Degree of statistical significance
pBCOV	Post Weaning Breech Cover
pBRWR	Post Weaning Breech Wrinkle
PCPT	Paternal Central Progeny Test
PEMD	Post Weaning Eye Muscle Depth
PFAT	Post Weaning Fat
Pigmentation traits	Fibre Pigmentation, Non-fibre Pigmentation, Recessive Black, Random Spot
PIRSA	Primary Industries and Resources South Australia
PWMMC	Peter Westblade Memorial Merino Challenge
PWT	Post Weaning Weight
PWWT	Post Weaning Weight
rg	Regression. Statistical tool used to measure relationships between two or more variables
RR	Reproduction Rate (%)
SAMM	South African Meat Merino
SARDI	South Australian Research and Development Institute
SL	Staple Length (mm)
SS	Staple Strength (N/ktex)
Style	Visual and tactile property of wool involving - crimp frequency, crimp definition, colour, dust penetration, staple structure, and handle (ie. softness).
UNE	The University of New England
Vic DPI	Victorian Government Department of Primary Industries
W	Weaning
wBRSTR	Weaner Breech Strike (%)
WEC	Worm Egg Count (egg/g)

Abbreviation	Definition
Wool Quality traits	Fleece Rot, Wool Colour, Wool Character, Dust Penetration, Staple Weathering and Staple Structure
Wt	Weight (general liveweight kg)
WWT	Weaning Weight (kg)
Y	Yearling
YEMD	Yearling Eye Muscle Depth (mm)
YFAT	Yearling Fat Depth (mm). The depth of subcutaneous fat measured at the C-site.
YLD	Yield (%). The proportion of a fleece sample remaining after relevant washing.
YWT	Yearling Weight (kg)