final report

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Best Practice Sheep Reproduction Management

A Review of Current Extension and Adoption

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Introduction and Background

A school of thought exists in the livestock industry that in light of higher sheep meat prices, sheep reproduction efficiency should be a priority for many sheep producers in Australia. However, there is little evidence that the average marking rate for the Australian sheep industry has improved over the past 15 years. Furthermore, there is little compelling evidence that technologies and management practices that have been promoted by R&D oriented organizations as best practice reproduction management techniques and systems have been broadly adopted by industry. This paper is the final report on an investigation into this phenomenon and makes recommendations as to the future management of best practice sheep reproduction innovations.

The investigation forms part of a series of reviews undertaken including:

- *LAMBPLAN: A Review of Adoption by the Australian Meat Sheep Breeding Industry (SHGEN.114)*

  This report details the history and development of the LAMBPLAN technology and service in the context of an evolving Australian lamb industry, the actual adoption of LAMBPLAN by various meat sheep breeding sectors and the adoption behaviour of the market for the LAMBPLAN innovation.

- *Pasture Utilisation and Natural Resource Management (COMM.112)*

  The report details historical research and development in the areas of pasture utilization and natural resource management and recommended best practice from that research, current extension initiatives that promote best practice pasture utilization and natural resource management, an assessment of pasture utilization of regional sheep and beef enterprise types in southern Australia and an assessment of felt-need among livestock producers in southern Australia for pasture utulisation and natural resource management practices. It also makes recommendations on initiatives that might be undertaken to develop pasture utilization and natural resource management practice in the future that are more likely to be widely adopted.

- *Hearts and Minds Discussion Paper and workshop*

  This report and the associated workshop was designed to communicate the main findings from the consultant's investigations in the areas of sheep genetics (LAMBPLAN), sheep reproduction and pasture utilization and natural resource management and to provide recommendations as to systems and practices that MLA might adopt with respect to managing their investments in innovation such that broader adoption of outputs is achieved.

The report discusses the adoption of sheep reproduction best practice management in five main sections:

- *Why is sheep reproduction efficiency important*
- *Trends in Australian flock reproduction performance*
- *Innovation in sheep reproduction management*
- *Extension in sheep reproduction best practice*
- Assessment of a felt-need for sheep reproduction best practice
- Recommendations

The methodology for the study is contained in Appendix 1.

Why is Sheep Reproduction Efficiency Important?

Other than to maintain a self-replacing merino flock or ensure an adequate pool of genetics for selective breeding practices, optimal sheep reproduction efficiency has not historically been a management priority for most Australian sheep producers. That is, surplus sheep have historically represented little value, if not an unnecessary cost.

Weaker markets for Australian wool and stronger markets for sheep meat have resulted in an emerging school of thought that reproduction efficiency should, intuitively, be emerging as a management priority for Australian sheep producers. However, this school of thought has by no means reached consensus across the broader industry. The economics of managing for improved reproduction performance is at best uncertain and at worst sub-economic. While some extension programs are actively promoting certain reproduction management practices, some advisers are encouraging producers not to focus on proactive reproduction management. Furthermore, there appears to be similar disparity among producers. The economics of proactively managing for optimal sheep reproduction efficiency in different sheep enterprise models is beyond the scope of this review. However, a separate study investigating this issue is currently being undertaken as a joint commission between Australian Wool Innovation (AWI) and Meat and Livestock Australia (MLA).

Poor sheep reproduction efficiency that manifests itself in high rates of lamb and weaner survival (postnatal survival) also raises a potential strategic industry issue. Certain livestock supply chains have demonstrated a propensity to boycott suppliers on the basis of animal welfare issues. There is an argument that if data clearly demonstrating poor rates of lamb and/or weaner survival, or even imagery for that matter, were to emerge the Australian wool and sheep meat industry would risk such a boycott. However, the recent boycotting of Australian wool by the United States based Abercrombie and Fitch on the basis of the practice of muelsing seems to have had limited impact on the global demand for Australian wool or indeed changes in blowfly prevention practices by producers. Nevertheless, the consequences of a global boycott of Australian sheep

products would be catastrophic and as such it is a risk that those charged with investing in the future of the industry should not ignore.

Trends in Australian Sheep Reproduction Performance

Trends in the Aggregate Australian Flock

There is currently approximately 57,000 Australian sheep enterprises. The Australian sheep industry can be classified according to three broad enterprise types – prime lamb specialists, sheep specialists and mixed sheep enterprises. Approximately 50 percent of Australian sheep enterprises are mixed sheep enterprises with prime lamb and sheep specialist enterprises account for approximately 25 percent each. This is demonstrated in Figure 1 below.

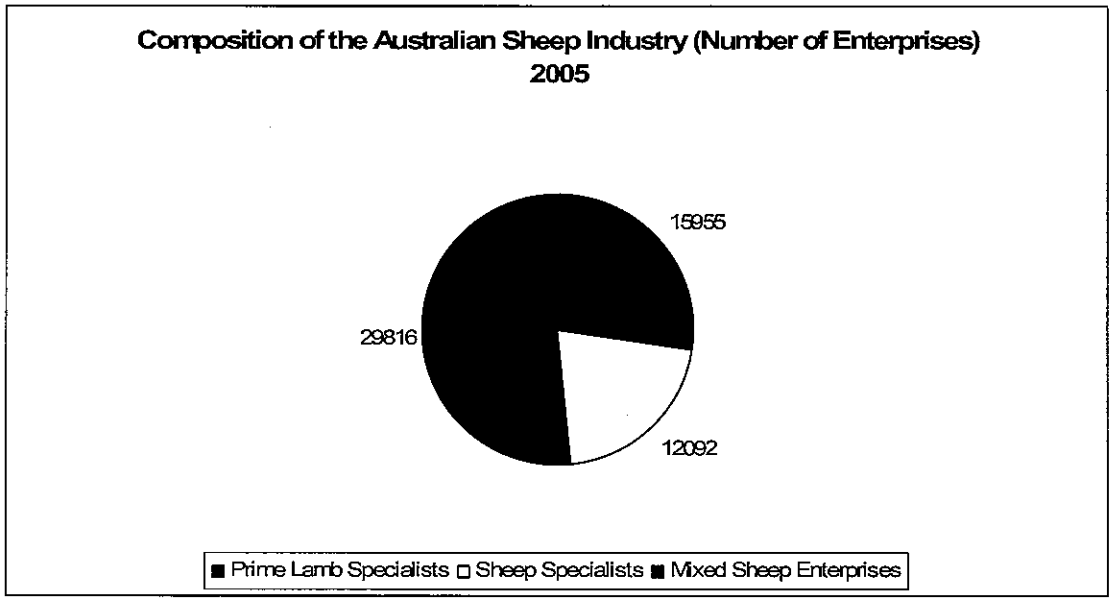


Figure 1 – Composition of the Australian Sheep Industry

The only statistical data that is maintained at an industry level is marking rate, which does not provide an indication as to whether losses are occurring as a result of failed conception or pre or post natal mortality.

The average marking rate for the Australian sheep industry over the past 15 years is approximately 77 percent[1]. Prime lamb specialists have the highest average marking

[1] ABARE Farm Survey Data (See Appendix 2)

rate among the three main sectors, demonstrating an average marking rate for the period 2001-05 of approximately 85 percent. Mixed sheep enterprises have the second highest average marking rate, demonstrating an average marking rate for the period 2001-05 of approximately 74 percent. Finally, sheep specialist enterprises demonstrated an average marking rate for the period 2001-05 of 71 percent. Importantly, none of the sectors have demonstrated a significant improvement in average marking rate over the past 10 to 15 years. This is demonstrated in Table 1 below.

Enterprise Sector	1990-2000 Average Marking Rate	2001-2005 Average Marking Rate
Prime Lamb Specialists	83.4	85.2
Sheep Specialists	73.0	71.2
Mixed Sheep Enterprises	75.3	74.1
Sheep Industry Total	77.2	76.8

Table 1 – Enterprise Sector Trends in Average Marking Rate

Another important observation is that there has been considerable volatility in average marking rate across annual seasons during the period under investigation. There was a period of dramatic decline in the average marking rate across all three sectors following the announcement by the Federal Government that the Wool Reserve Price Scheme was to be abolished. This decreasing trend continued until the end of the 1994 drought. The average marking rate then recovered through the second half of the 1990s. Since 2000, average sector marking rates for lamb specialists and mixed sheep enterprises have plateaued at around 85 and 77 percent respectively and were affected only slightly by the 2002-03 drought. However, the average marking rate for the sheep specialist sector declined dramatically during the 2002-03 drought, recovering to around 80 percent in 2005. This is demonstrated in Figure 2 below.

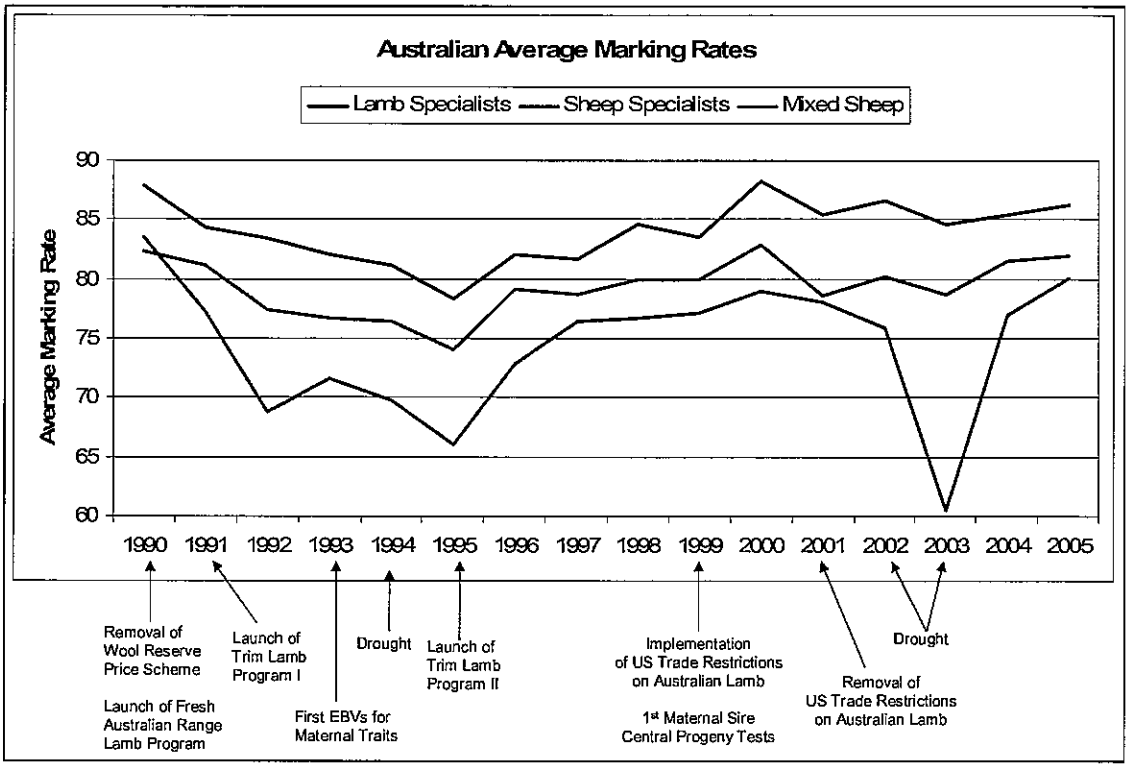


Figure 2 – Annual Trends in Average Marking Rates

Regional Enterprise Trends

Previous studies examining trends and patterns in reproduction efficiency have noted that there is a large variation in reproductive performance of flocks both within and between regions.[2] The analysis that forms part of this investigation concurs with these previous findings.

In order to observe this variation, the average marking rate for prime lamb specialists, sheep specialists and mixed enterprise sheep farms in each AAGIS region for the period 1990 to 2000 were compared with average marking rates for the period 2001 to 2005. Table 2 overleaf demonstrates the regional enterprise sectors that, according to ABARE farm survey data, achieved average marking rates for the period 1990 to 2000 in excess of 80 percent. It can be observed that average marking rates in excess of 80 percent for

[2] Walker, S., Kleeman, D. and Bawden, S. (2003), *Sheep Reproduction in Australia: Current Status and Potential for Improvement Through Flock Management and Gene Discovery,* South Australian Research and Development Institute and Meat and Livestock Australia.

the period 1990-2000 were achieved by 42 percent of the total regional sheep enterprises and that these regional sheep enterprises were restricted to twelve AAGIS regions in south east Australia.

1990 - 2000 Average Marking Rate Performance

90 percent plus		85 to 90 percent		80 to 85 percent	
Lamb Specialists		*Lamb Specialists*		*Lamb Specialists*	
South East	90.8	Mallee	88.4	Mid North, Murraylands and York Peninsula	84.5
		New South Wales Tablelands	88.3	Riverina	84.3
		Central Northern	87.2	North West Slopes & Plains	83.3
		Northern Tasmania, Midland & Huon	85.1	Gippland & Western Districts	83.3
				Central West	82.7
				Eyre Peninsula	80.3
				Northern & Eastern Wheatbelt	80.1
		Sheep Specialists		*Sheep Specialists*	
		South East	89.5	New South Wales Tablelands	81.4
		Mallee	85.4	Northern Tasmania, Midland & Huon	80.6
		Mixed Enterprises		*Mixed Enterprises*	
		South East	88.7	Mid North, Murraylands and York Peninsula	84.2
		Mallee	88.6	New South Wales Tablelands	83.9
		Gippland & Western Districts	88.6	Northern Tasmania, Midland & Huon	83.7
		Central Northern	85.0	Riverina	80.9
				Central West	80.8

Table 2 – Regional Enterprise Sector Average Marking Rates – ABARE Data 1990 to 2000

This analysis approximately corresponds to the marking rates reported in the 1997 census data which, as demonstrated in Figure 1 overleaf, indicates that enterprise recording marking rates in excess of 80 percent are concentrated in the south east of Australia.

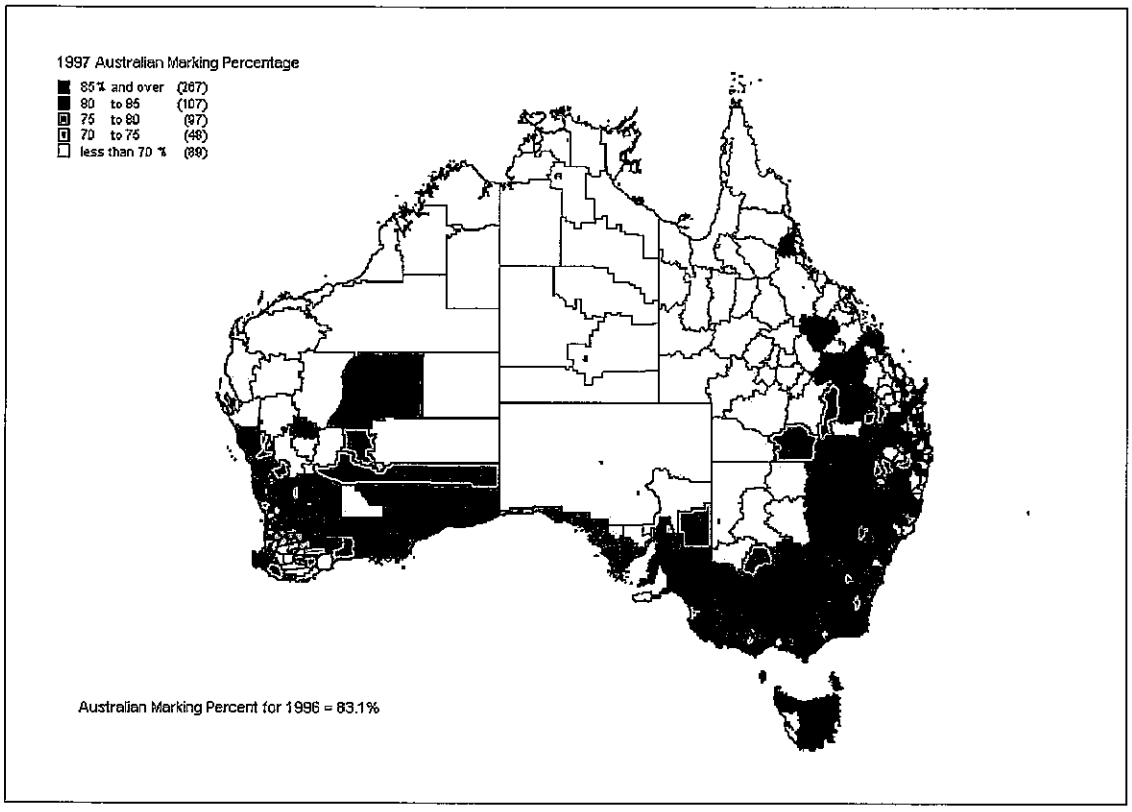


Figure 3 – Average Marking Rates - Census Data 1997

If we compare this data to the average marking rates for the period 2001 to 2005, we find that the total number of regional enterprise sectors that have achieved average marking rates in excess of 80 percent has increased slightly to 46 percent of all regional sheep enterprise sectors and that those enterprise sectors came from a total of fourteen AAGIS regions. However, there has been a considerable skew within the set of regional enterprise sectors that were already achieving average marking rates in excess of 80 percent toward even higher average marking rates. This is demonstrated in Table 3 below.

2001 - 2005 Average Marking Rate Performance					
90 percent plus		85 to 90 percent		80 to 85 percent	
Lamb Specialists		*Lamb Specialists*		*Lamb Specialists*	
Central West	92.6	Gippland & Western Districts	89.5	Northern & Eastern Wheatbelt	83.9
Central Northern	92.0	South East	88.2	Riverina	83.5
Wimmera	90.2	Mallee	88.1	Mid North, Murraylands and York Peninsula	82.6
		New South Wales Tablelands	87.1	Northern Tasmania, Midland & Huon	82.4
		Eyre Peninsula	85.1		
		Sheep Specialists		*Sheep Specialists*	
		South East	88.7	Gippland & Western Districts	84.3
				Central Northern	82.9
				New South Wales Tablelands	82.0
				North West Slopes & Plains	81.3
				Central & Southern Wheatbelt	80.0
Mixed Enterprises		*Mixed Enterprises*		Mixed Enterprises	
Central Northern	94.5	Central West	88.2	Gippland & Western Districts	84.6
		Wimmera	87.8	Riverina	83.0
		South East	87.0	Eyre Peninsula	81.6
		Mallee	86.0	Mid North, Murraylands and York Peninsula	80.1

Table 3 – Regional Enterprise Sector Average Marking Rates – ABARE Data 2001 to 2005

Most notably, we can observe a marked improvement in the number of prime lamb regional sectors achieving an average marking rate for the period in excess of 90 percent and the total number of sheep specialist regional sectors achieving an average marking rate in excess of 80 percent for the period. Interestingly, mixed sheep enterprises in the Great Northern region achieved the highest average marking rate for the period 2001 to 2005. While the enterprises achieving high average marking rates are still concentrated in south eastern Australia, the density of such enterprises in south east Australia has improved, and pockets of performance are emerging in Western Australia.

Again, the data presented in Table 3 above approximately corresponds to the marking rates presented in the 2001 Census data, with the density of enterprises experiencing marking rates in excess of 80 percent increasing in south east Australia as demonstrated in Figure 2 below.

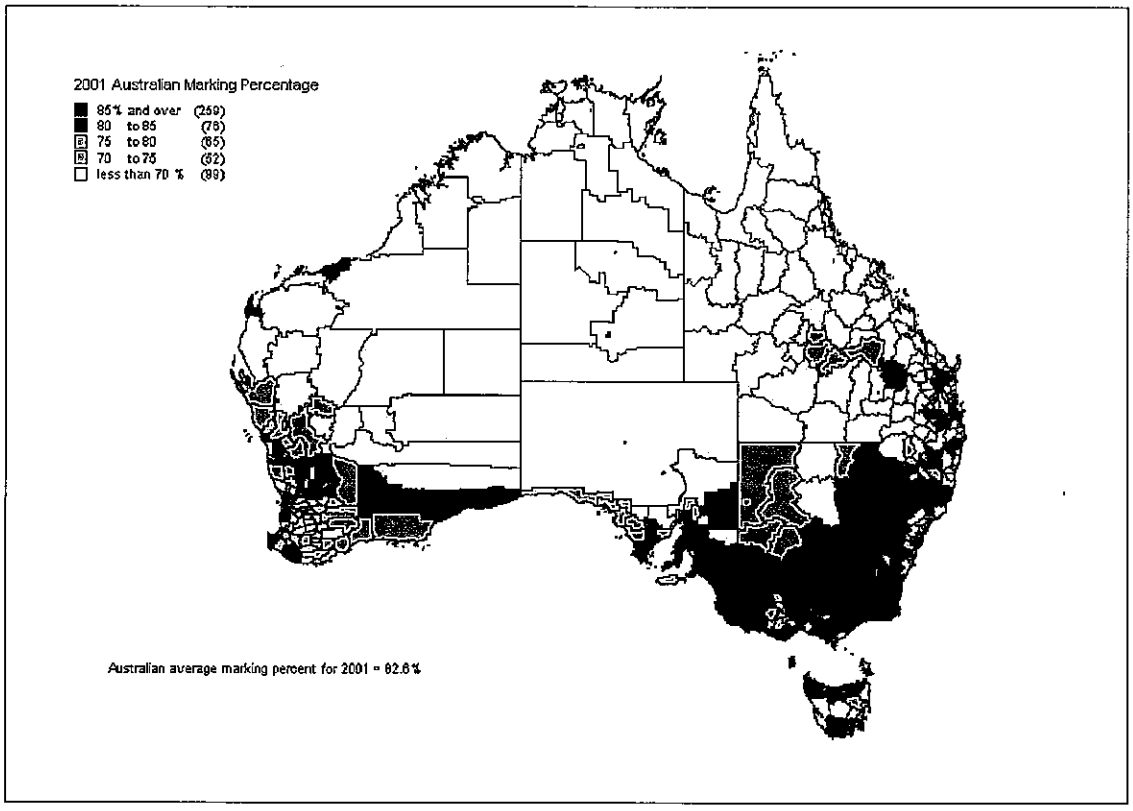


Figure 4 – Australian Average Marking Rates – Census Data 2001

This analysis suggests that improvements in reproductive performance as measured by improved marking rate have been largely confined to the high-to-medium rainfall zones of south eastern Australia. These locations typically demonstrate climatic and agronomic conditions more favourable to successful reproduction. However, importantly, these locations also tend to have more significant concentrations of cross-bred and other non-merino ewes[3]. This is demonstrated in Figure 5 overleaf.

[3] ABARE Farm Survey Data

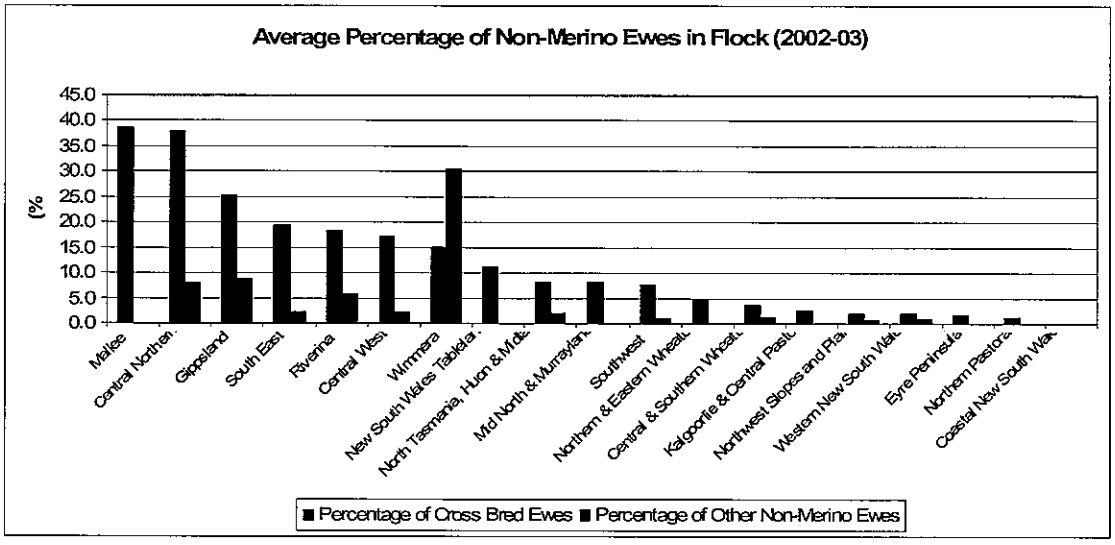


Figure 5 - Regional Distribution of Cross Bred and Non-Merino Ewes

Regional Enterprises with Consistently High Marking Rates

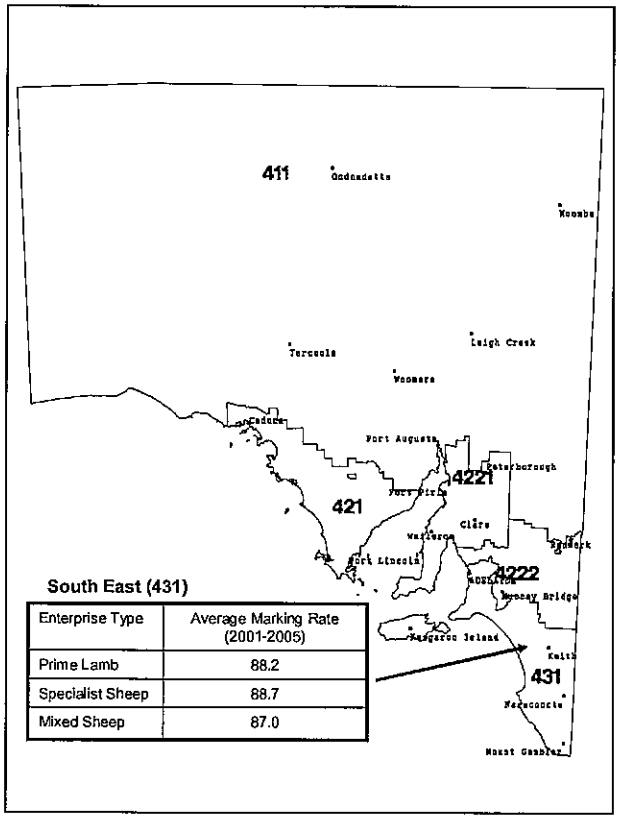
A total of eleven regional enterprise sectors demonstrated average marking rates in excess of 80 percent for the period 2001-2005, despite not having improved their average marking rate over that for the 1990-2000 period. These regional enterprise sectors were located in a total of 7 AAGIS Regions in the south east of Australia, namely:

- South East Region of South Australia
- Midnorth, Murraylands and York Peninsula Region of South Australia
- Mallee Region of Victoria
- Gippsland and Western Districts Region of Victoria
- New South Wales Tablelands Region
- Riverina Region of New South Wales
- Northern Tasmania, Huon and Midlands Region

Furthermore, six of the enterprises achieving stable average marking rates in excess of 80 percent were prime lamb enterprises, four were mixed sheep enterprises and 1 was a specialist sheep enterprise.

The enterprise sectors in these regions that achieved stable marking rates in excess of 80 percent are discussed below.

Enterprises in the South East Region – South Australia



South East (431)

Enterprise Type	Average Marking Rate (2001-2005)
Prime Lamb	88.2
Specialist Sheep	88.7
Mixed Sheep	87.0

Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	512
Average SR Prime Lamb	3.3
Average SR Sheep Specialists	3.7
Average SR Mixed Sheep	2.0
Average Prime Lamb Sample (n)	30
Average Sheep Specialist Sample (n)	15
Average Mixed Sheep Sample (n)	33

Approximately 50 percent of merino ewes in the South East region are mated with non-merino rams. This suggests that there is a strong enterprise focus on lamb and meat production in this region. Interestingly, approximately 1/8th of the ewes in the region are joined to border Leicester rams, which are a maternal sire breed. This is demonstrated in Figure 6 below.

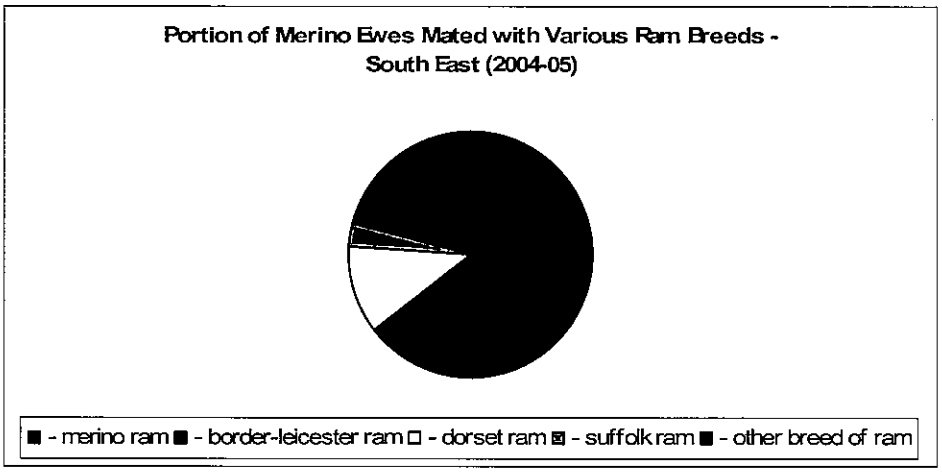


Figure 6 – Portion of Merino Ewes Mated with Various Ram Breeds – South East

Figure 7 below demonstrate trends in average marking rates for prime lamb specialists, sheep specialists and mixed sheep enterprises in the South Eastern Region of South Australia.

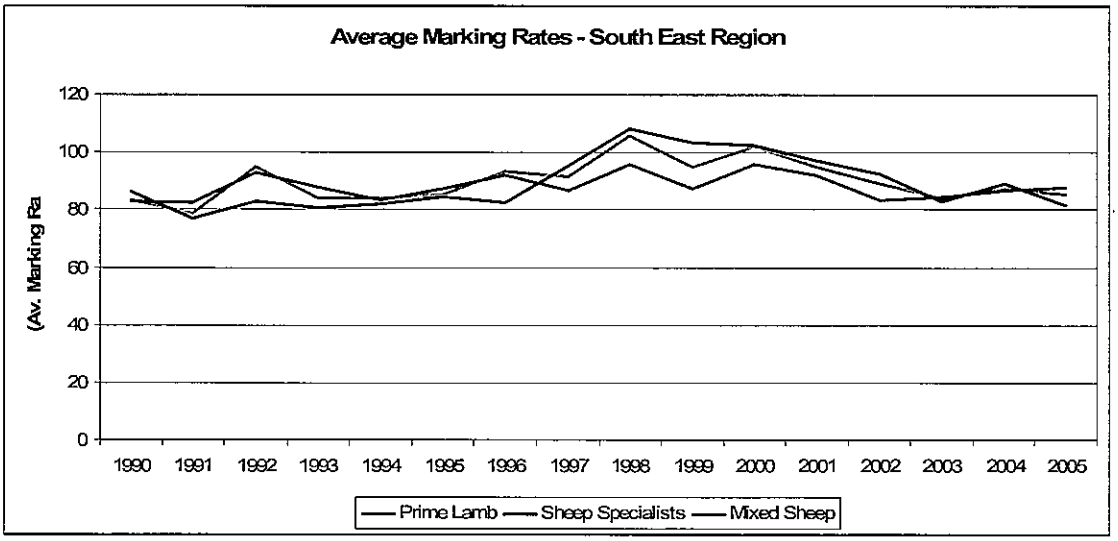
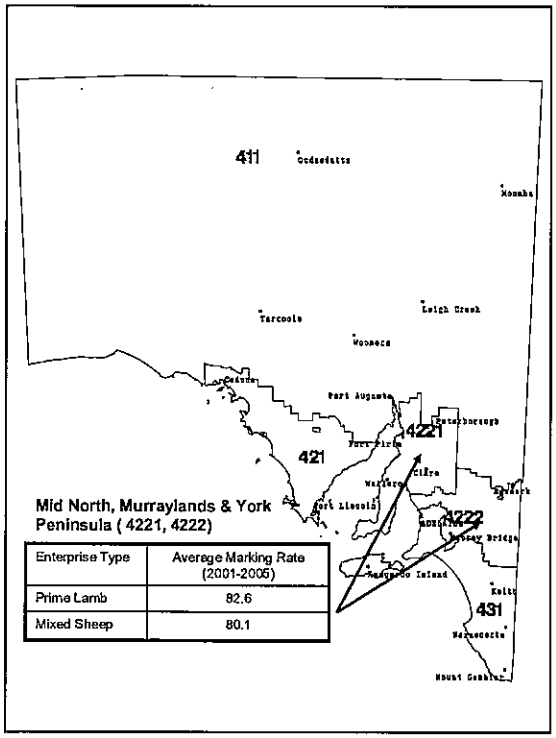


Figure 7 – Average Marking Rates – South East Region

Enterprises in the Mid North, Murraylands and York Peninsula Region of South Australia



Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	414
Average SR Prime Lamb	Na
Average SR Mixed Sheep	1.3
Average Prime Lamb Sample (n)	26
Average Mixed Sheep Sample (n)	43

As demonstrated in Figure 8 below, more than half of the merino ewes in the Mid North, Murraylands and York Peninsula Region are mated with non-merino ewes. This suggests there is a strong trend toward meat production in this region.

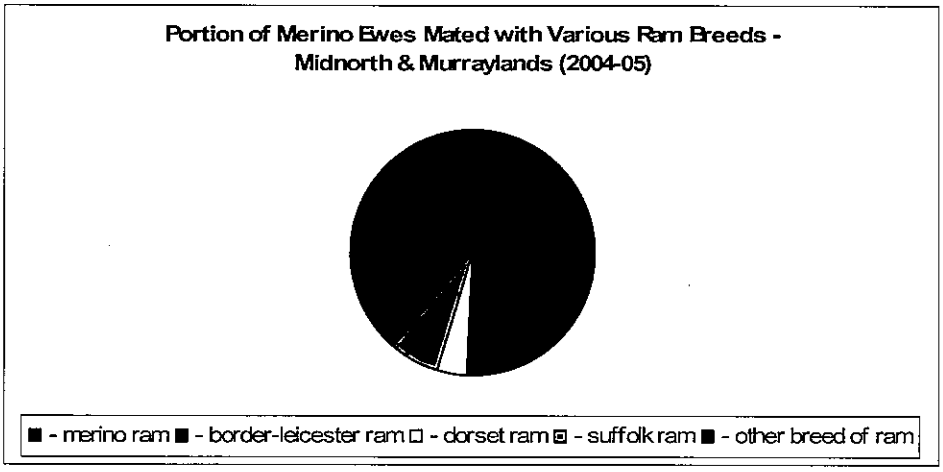


Figure 8 – Portion of Merino Ewes Mated with Various Ram Breeds – Mid North, Murraylands and York Peninsula

Figure 9 below demonstrates trends in average marking rates for prime lamb specialists and mixed sheep enterprises in the Mid North, Murraylands and York Peninsula Region.

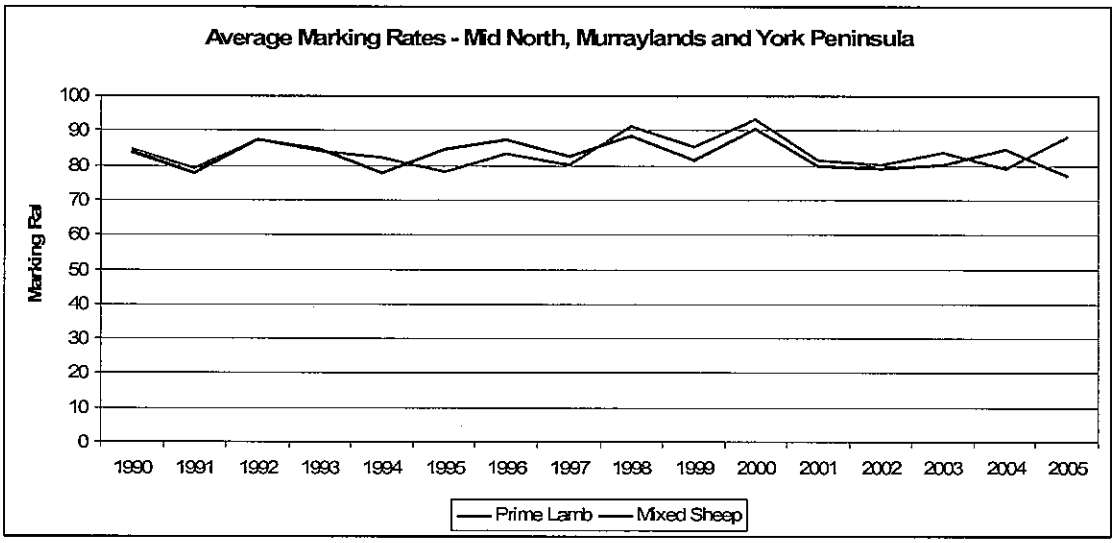
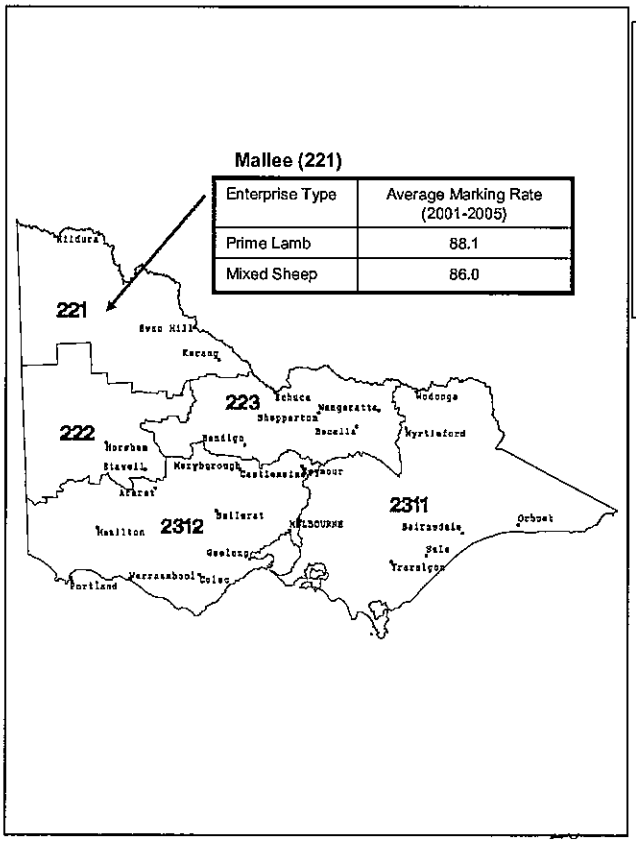


Figure 9 – Average Marking Rates – Mid North, Murraylands and York Peninsula

Enterprises in the Mallee Region of Victoria



Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	331
Average SR Prime Lamb	1.3
Average SR Mixed Sheep	0.8
Average Prime Lamb Sample (n)	25
Average Mixed Sheep Sample (n)	30

The Mallee Region is primarily a prime lamb production region, with the majority of merino ewes in the region joined to non-merino ram breeds. Dorsets are the most common terminal sire used in the region, accounting for over 50

percent of joinings with merino ewes in 2004-05. This is demonstrated in Figure 10 below.

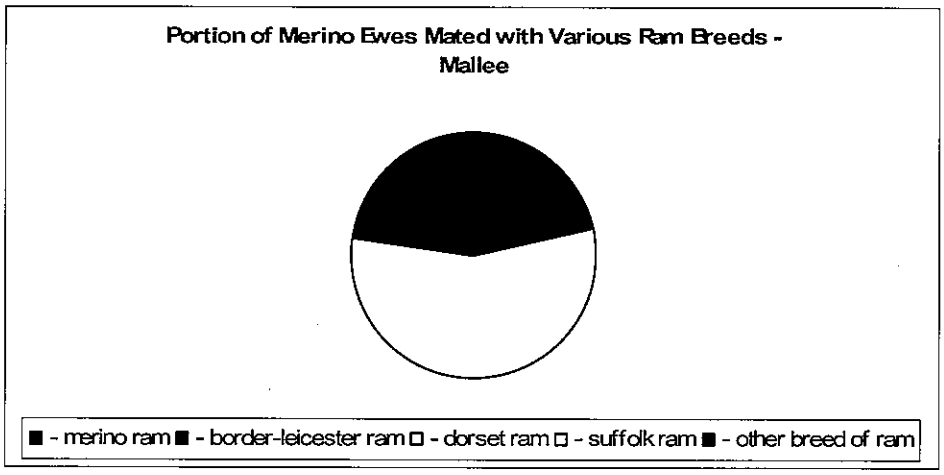


Figure 10 – Portion of Merino Ewes Mated with Various Ram Breeds – Mallee Region

Trends in marking rates in the Mallee Region are demonstrated in Figure 11 below.

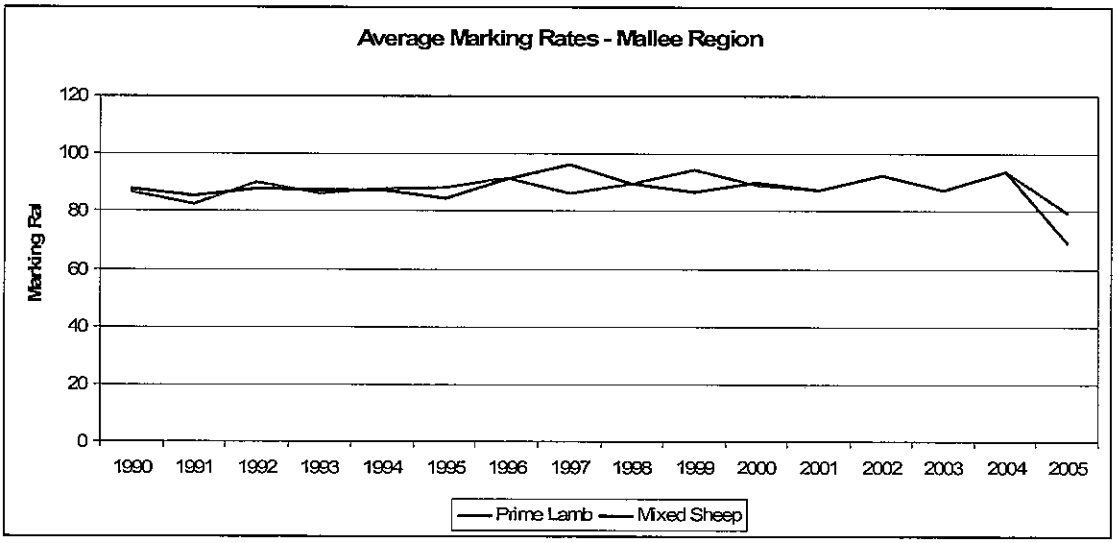
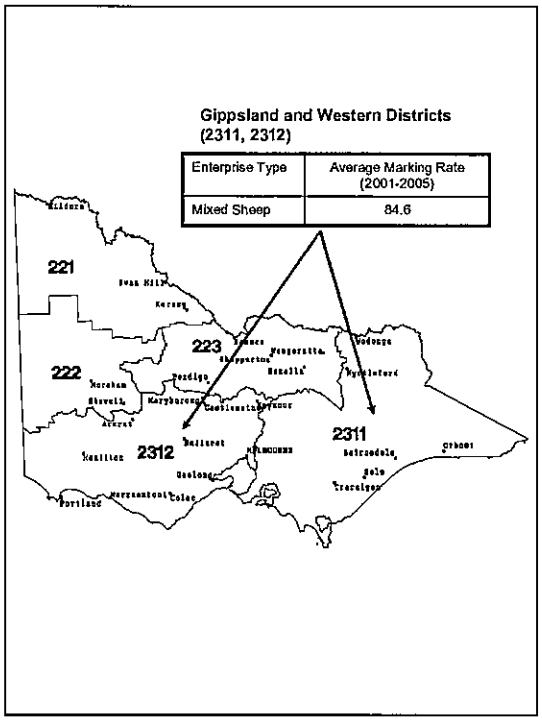


Figure 11 – Average Marking Rate – Mallee Region

Enterprises in the Gippsland and Western Districts Region of Victoria



Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	787
Average SR Mixed Sheep	3.4
Average Mixed Sheep Sample (n)	35

Pure merinos comprise a significant portion of the flock in the Gippsland and Western Districts Region, with well over 70 percent of merino ewes mated with merino rams. This is demonstrated in Figure 12 below and suggests a much greater focus on wool production rather than meat production in the Gippsland and Western Districts region.

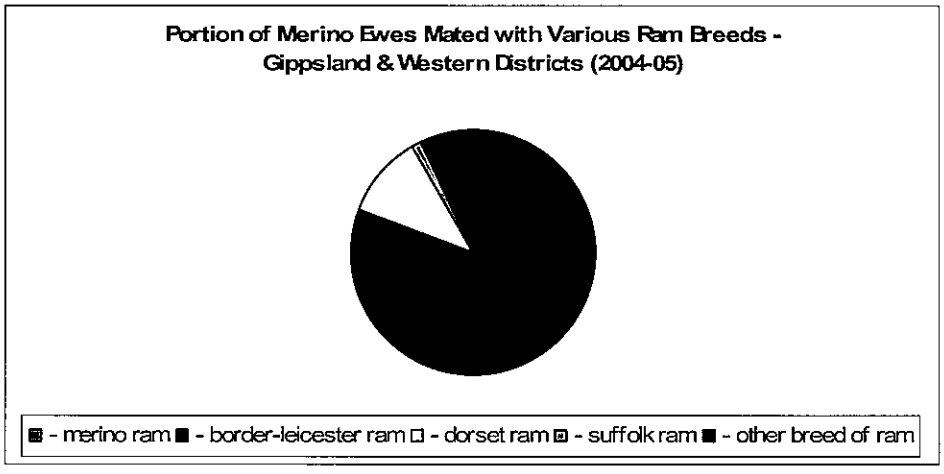


Figure 12 – Portion of Merino Ewes Mated with Various Ram Breeds – Gippsland & Western Districts

Figure 13 below demonstrates the trend in average marking rate among mixed sheep enterprises in the Gippsland and Western Districts of Victoria.

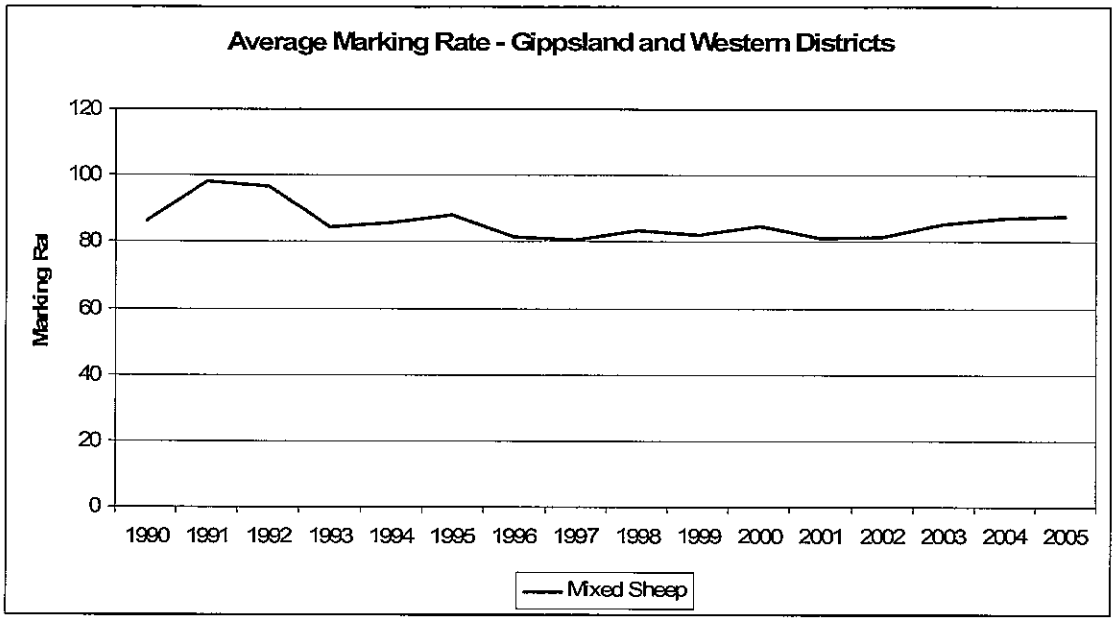
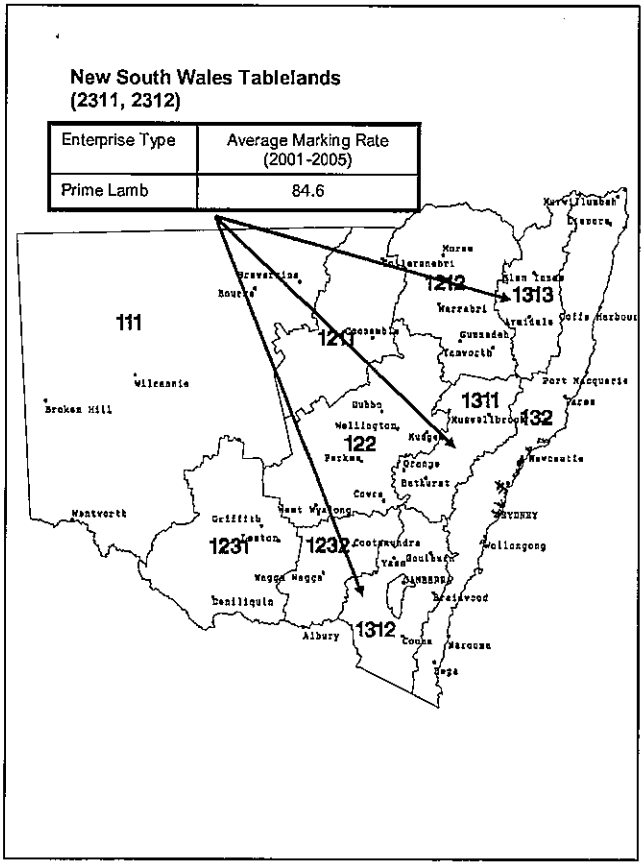


Figure 13 – Average Marking Rate – Gippsland and Western Districts

Enterprises in the New South Wales Tablelands Region



Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	734
Average SR Prime Lamb	2.7
Average Mixed Sheep Sample (n)	22

The New South Wales Tablelands is primarily a wool producing region and as such the vast majority of merinos ewes are joined to merino rams. Interestingly, of the small portion of merino-ewes that are joined to non-merino rams, approximately 1/3 of those are joined to a maternal sire breed, Border Leicester. This is demonstrated in Figure 14 below.

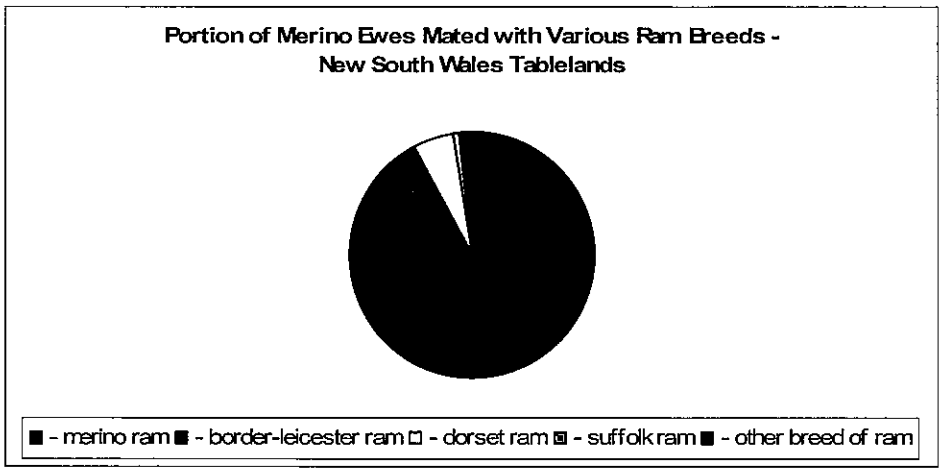


Figure 14 – Portion of Merino Ewes Mated with Various Ram Breeds – New South Wales Tablelands

Figure 15 below demonstrates the trend in average marking rate among prime lamb producers in the New South Wales Tablelands Region.

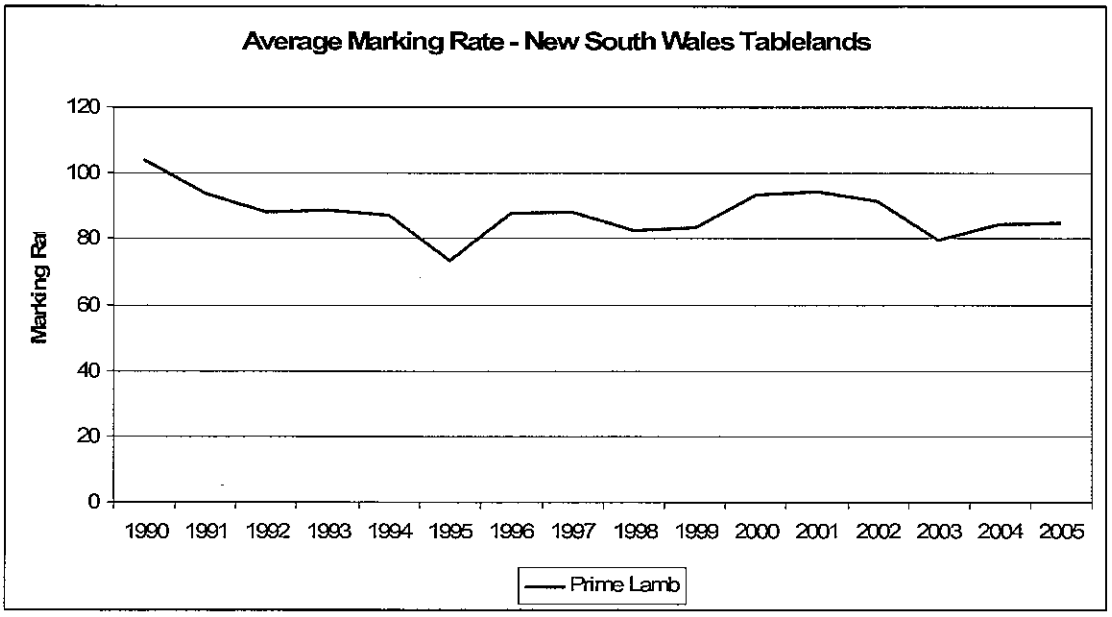
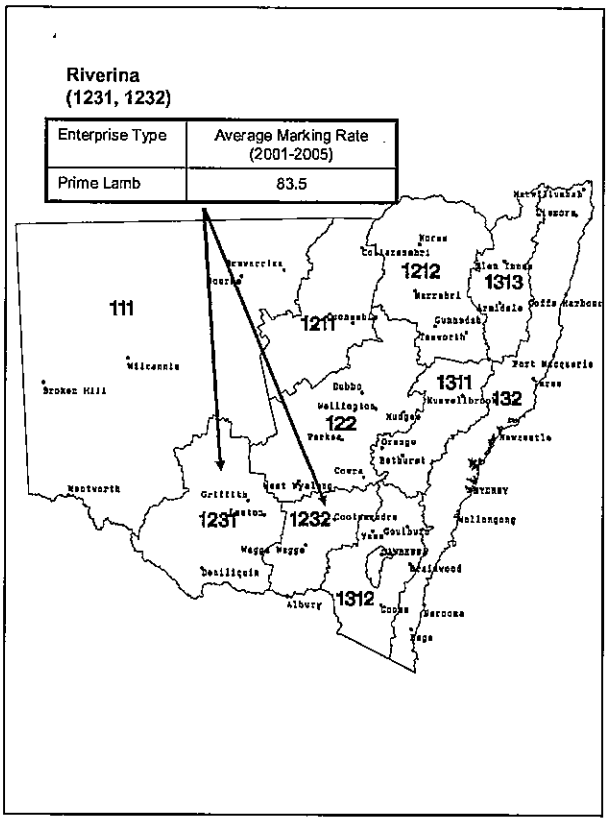


Figure 15 – Average Marking Rate – New South Wales Tablelands

Enterprises in the Riverina Region of New South Wales



Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	586
Average SR Prime Lamb	2.4
Average Mixed Sheep Sample (n)	41

The Riverina region of New South Wales is primarily a wool producing region, with the vast majority of merino ewes joined to merino rams. This is demonstrated in Figure 16 below.

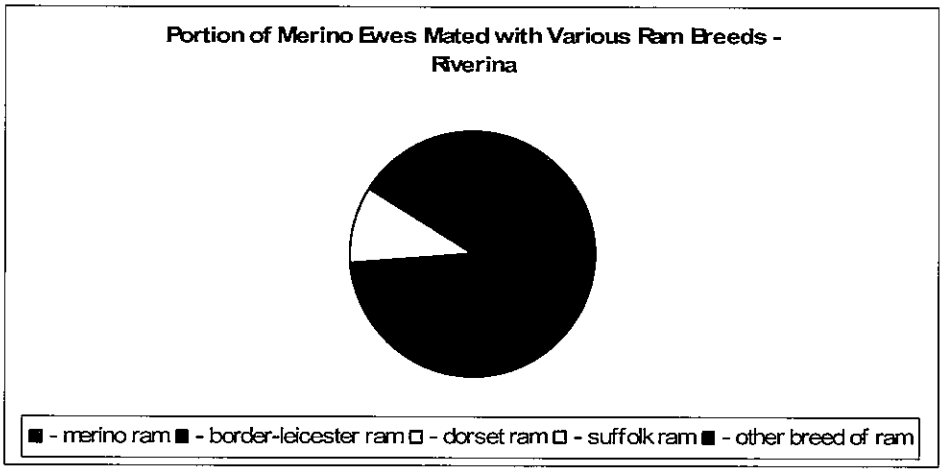


Figure 16 – Portion of Merino Ewes Mated with Various Ram Breeds - Riverina

Figure 17 below demonstrates the trend in average marking rate among prime lamb producers in the Riverina region of New South Wales.

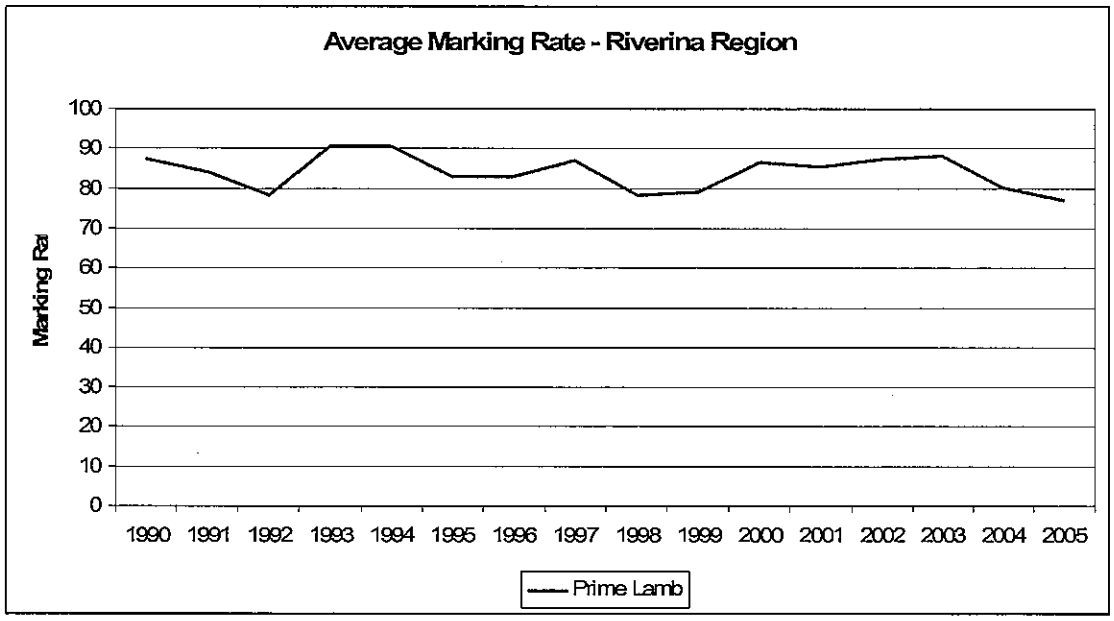
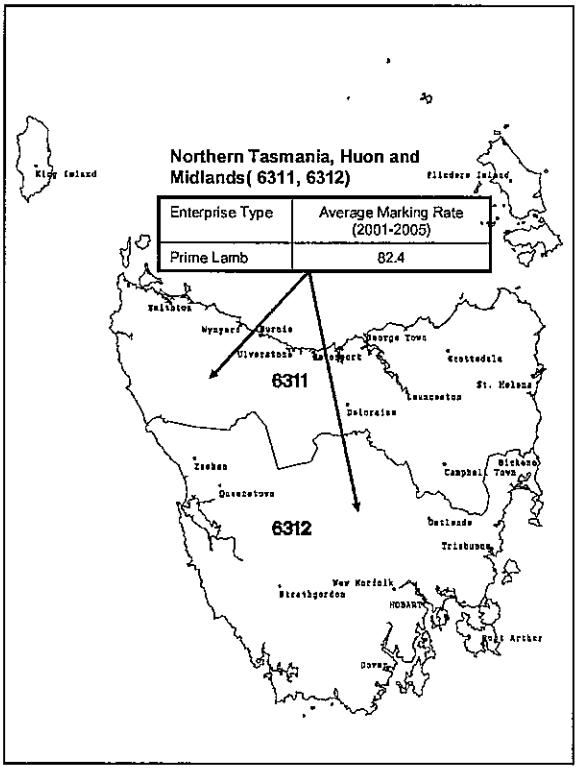


Figure 17 – Average Marking Rate – Riverina Region

Enterprises in Northern Tasmania, Huon and Midlands Region



Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	1020
Average SR Prime Lamb	3.2
Average Mixed Sheep Sample (n)	30

Northern Tasmania, Huon and the Midlands Region is primarily a wool producing region, with the vast majority of merino ewes joined to merino rams. This is demonstrated in Figure 18 overleaf.

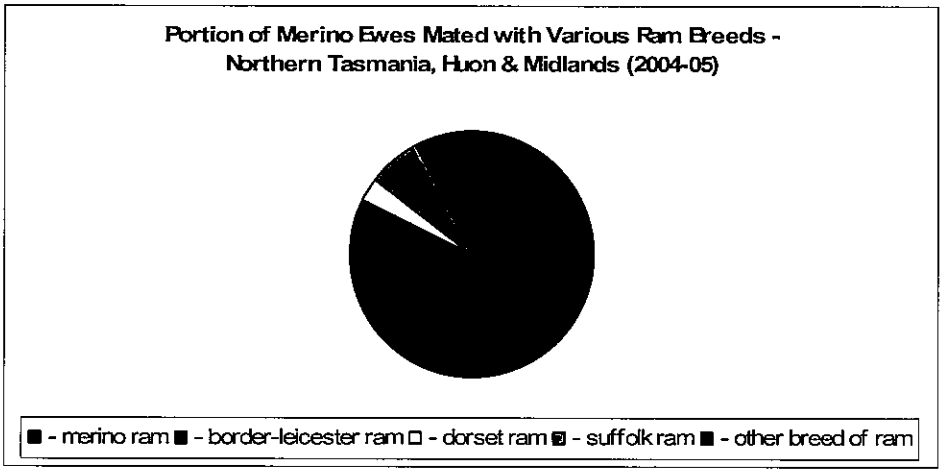


Figure 18 – Portion of Merino Ewes Mated with Various Ram Breeds – Northern Tasmania, Huon and Midlands

Figure 19 below demonstrate the trend in average marking rate among prime lamb producers in Northern Tasmania, Huon and Midlands Region.

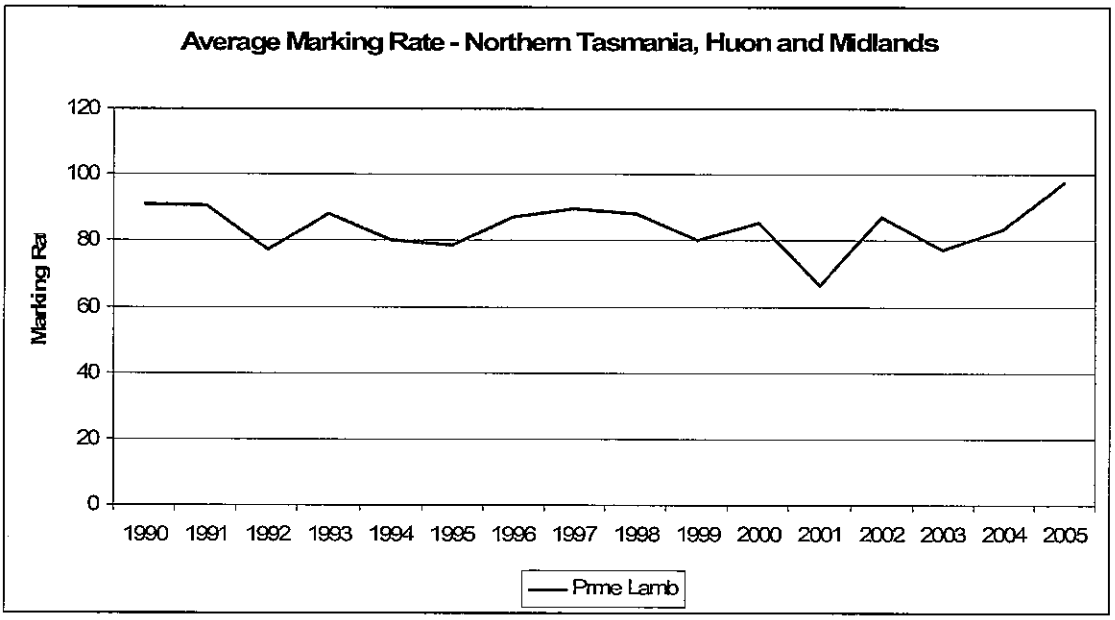


Figure 19 – Average Marking Rate – Northern Tasmania, Huon and Midlands

Regional Enterprises Demonstrating Improvement in Average Marking Rate

By comparing average marking data for the period 1990-2000 with average marking data for the period 2001 to 2005 we can identify regional enterprise sectors that have achieved an increase in average marking rate. Enterprises achieving significant improvements in average marking rate (excess of 5.0%) were confined to the Wimmera, Central West, North West Slopes and Plains, Gippsland and Western Districts and Central Northern Regions of south eastern Australia. This is demonstrated in Tables 4, 5 & 6 below.

Improvement in Excess of 5.0 Percent			Improvement of between 0.1 and 5.0 Percent		
Region	**Percent Improvement in Av Marking Rate**	**2001-2005 Av Marking Rate**	**Region**	**Percent Improvement in Av Marking Rate**	**2001-2005 Av Marking Rate**
Wimmera	10.3	90.2	Central Northern	4.8	92.6
Central West	9.9	92.6	Eyre Peninsula	4.8	85.1
Gippsland & Western Districts	6.2	89.5	Northern & Eastern Wheatbelt	3.8	83.9
			Central & Southern Wheatbelt	2.3	79.7
			Southwest	0.8	76.3

Table 4 -Prime Lamb Regional Enterprise Sectors Achieving Improvement in Average Marking Rate – ABARE Farm Survey Data

Improvement in Excess of 5.0 Percent			Improvement of Between 0.1 and 5.0 Percent		
Region	Percent Improvement in Av Marking Rate	2001-2005 Av Marking Rate	Region	Percent Improvement in Av Marking Rate	2001-2005 Av Marking Rate
Northwest Slopes & Plains	9.3	81.3	Central West	4.2	76.8
Gippsland & Western Districts	7.5	84.3	Central Northern	4.0	82.9
Wimmera	7.0	78.1	Southwest	2.5	76.8
			Central & Southern Wheatbelt	2.0	80.0
			New South Wales Tablelands	0.5	82.0

Table 5 - Sheep Specialist Regional Sectors Achieving Improved Average Marking Rates – ABARE Farm Survey

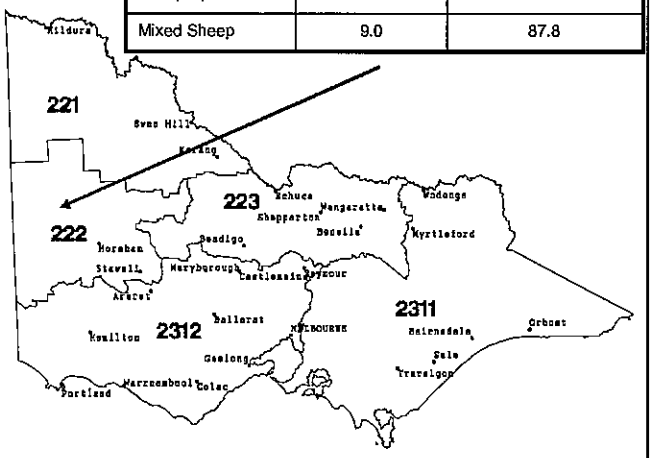
Improvement in Excess of 5.0 Percent			Improvement of Between 0.1 and 5.0 Percent		
Region	Percent Improvement in Av Marking Rate	2001-2005 Av Marking Rate	Region	Percent Improvement in Av Marking Rate	2001-2005 Av Marking Rate
Central Northern	9.6	94.5	Eyre Peninsula	2.9	81.6
Wimmera	9.0	87.8	Northern & Eastern Wheatbelt	2.3	78.0
Central West	7.4	88.2	Riverina	2.2	83.0
			Central & Southern Wheatbelt	1.2	79.1

Table 6 - Mixed Sheep Enterprise Regional Sectors Achieving Improved Average Marking Rates – ABARE Farm Survey

Enterprises in the Wimmera Region

Wimmera (223)

Enterprise Type	Marking Rate Improvement (1990-2000 vs 2001-2005)	2001-2005 Average Marking Rate
Prime Lamb	10.3	90.2
Sheep Specialists	7.0	78.1
Mixed Sheep	9.0	87.8



Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	432
Average SR Prime Lamb	2.8
Average SR Sheep Specialists	4.2
Average SR Mixed Sheep	1.4
Average Prime Lamb Sample (n)	22
Average Sheep Specialist Sample (n)	11
Average Mixed Sheep Sample (n)	31

While most of the merino ewes in the Wimmera region are joined to merino rams, over 30 percent are joined to non-merino rams. This is demonstrated in Figure 20 below.

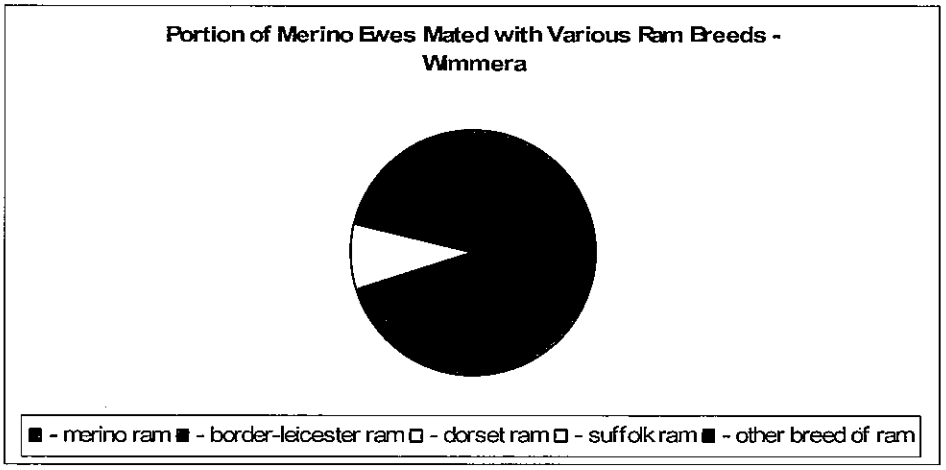


Figure 20 – Portion of Merino Ewes Mated with Various Ram Breeds – Wimmera Region

The trend in average marking rate for prime lamb, sheep specialist and mixed sheep enterprises in the Wimmera Region is demonstrated in Figure 21 below.

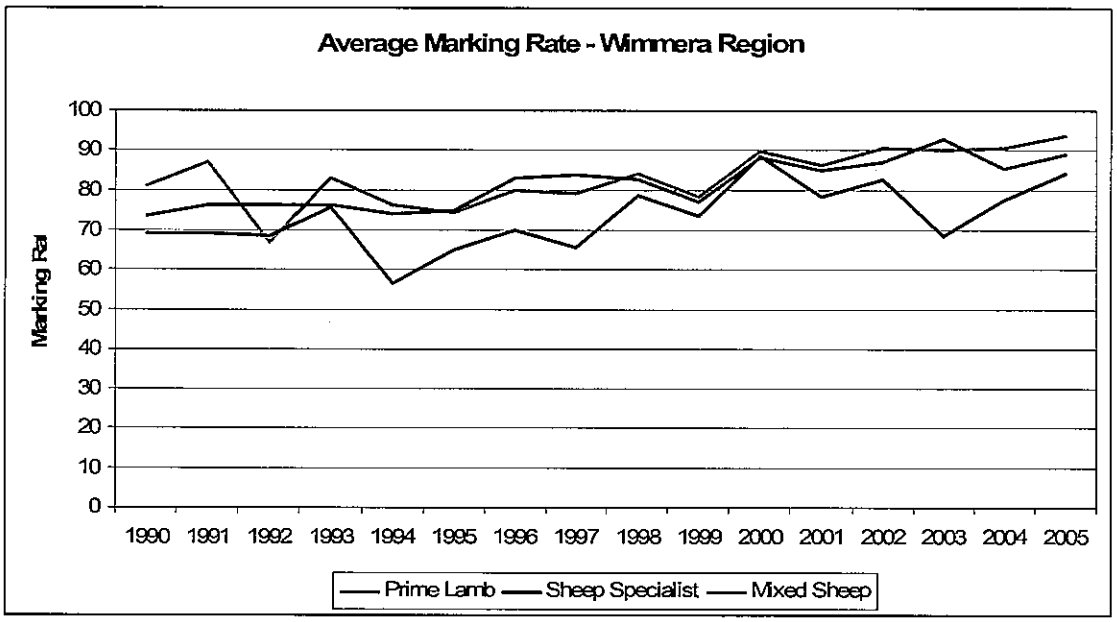
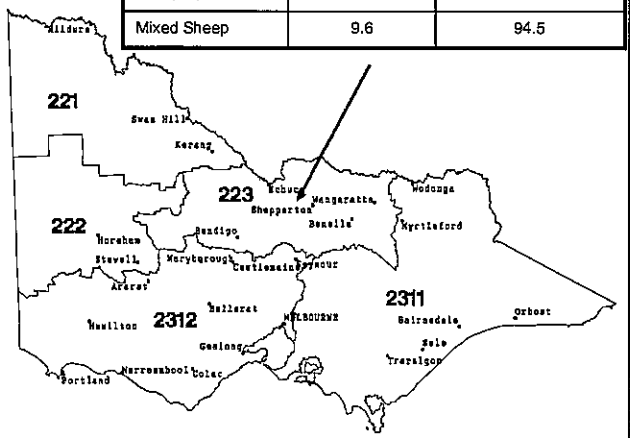


Figure 21 – Average Marking Rate – Wimmera Region

Enterprises in the Central Northern Region of Victoria

Central Northern (223)

Enterprise Type	Marking Rate Improvement (1990-2000 vs 2001-2005)	2001-2005 Average Marking Rate
Prime Lamb	4.8	92.6
Sheep Specialists	4.0	82.9
Mixed Sheep	9.6	94.5



Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	476
Average SR Prime Lamb	3.2
Average SR Sheep Specialists	2.8
Average SR Mixed Sheep	2.0
Average Prime Lamb Sample (n)	27
Average Sheep Specialist Sample (n)	11
Average Mixed Sheep Sample (n)	32

While the majority of merino ewes in the Central Northern Region are joined to merino rams, over 1/3 are joined to non-merino rams. Interestingly, a maternal sire breed, Border Leicester, account for a significant portion of the non-merino joinings. This is demonstrated in Figure 22 below.

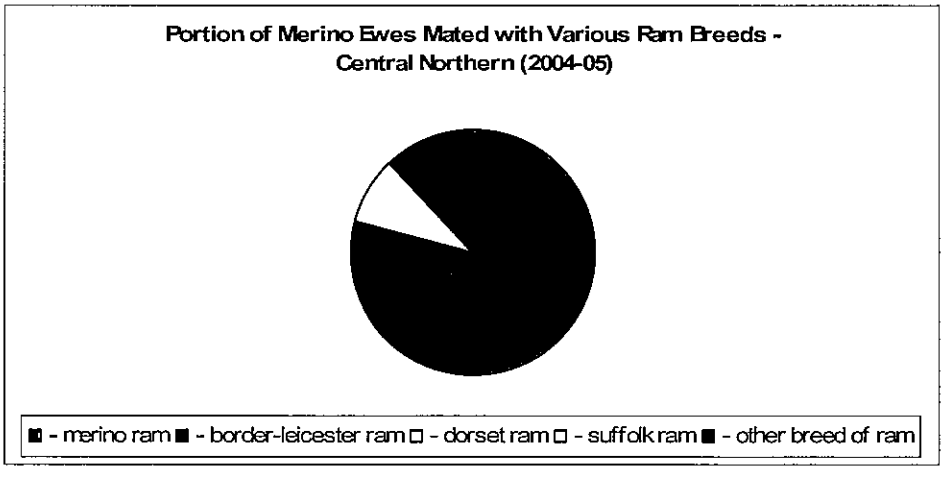


Figure 22 – Portion of Merino Ewes Mated with Various Ram Breeds – Central Northern

Figure 23 below demonstrates the trends in average marking rate for prime lamb, sheep specialist and mixed sheep enterprises in the Central Northern Region.

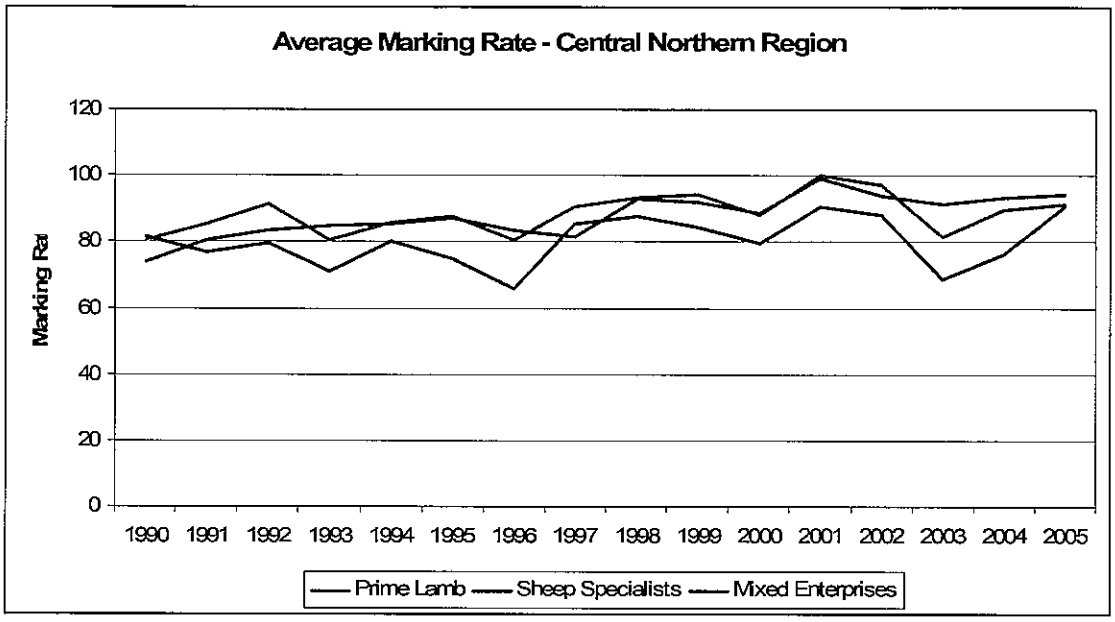
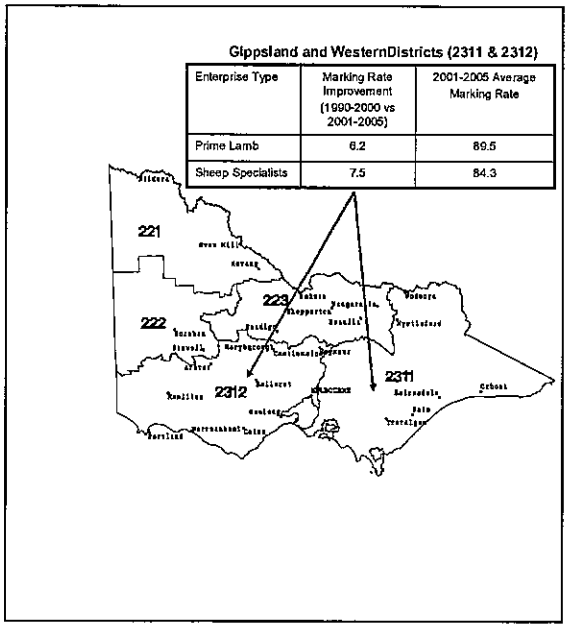


Figure 23 – Average Marking Rate – Central Northern Region

Enterprises in the Gippsland and Western Districts



Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	801
Average SR Prime Lamb	4.7
Average SR Sheep Specialists	5.8
Average Prime Lamb Sample (n)	37
Average Sheep Specialist Sample (n)	27

Pure merinos comprise a significant portion of the flock in the Gippsland and Western Districts Region, with well over 70 percent of merino ewes mated with merino rams. This suggests a much greater focus on wool production rather

than meat production in the Gippsland and Western Districts region. Interestingly Border Leicester sires account for a significant portion of non-merino joinings. This is demonstrated in Figure 24 below.

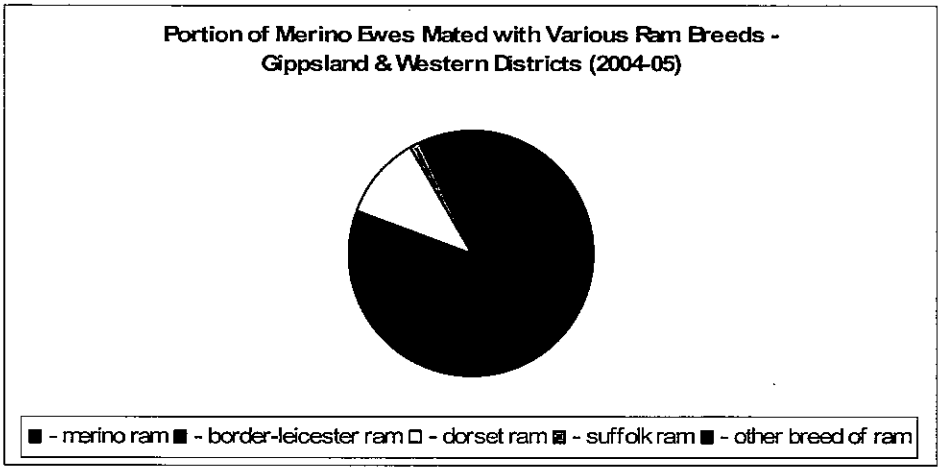


Figure 24 – Portion of Merino Ewes Mated with Various Ram Breeds – Gippsland and Western Districts

The trends in average marking rates among prime lamb and sheep specialists in the Gippsland and Western Districts Region is demonstrated in Figure 25 below.

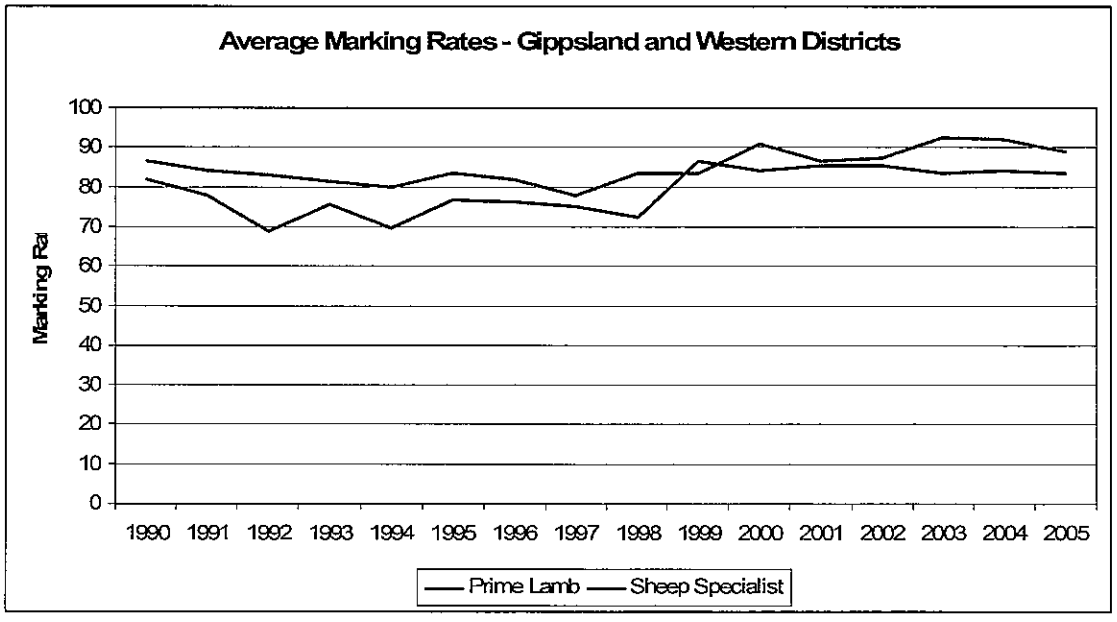
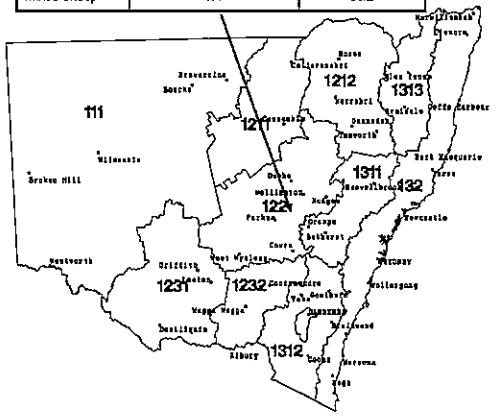


Figure 25 – Average Marking Rates Gippsland and Western Districts

Enterprises in the Central West Region

Central West (122)

Enterprise Type	Marking Rate Improvement (1990-2000 vs 2001-2005)	2001-2005 Average Marking Rate
Prime Lamb	9.9	92.6
Specialist Sheep	4.2	76.8
Mixed Sheep	7.4	88.2



Region Ag Conditions and Sample	
Average Annual Rainfall (mm)	605
Average SR Prime Lamb	2.3
Average SR Sheep Specialists	2.3
Average SR Mixed Sheep	1.7
Average Prime Lamb Sample (n)	30
Average Sheep Specialist Sample (n)	11
Average Mixed Sheep Sample (n)	46

The majority of merino ewes in the Central West Region of New South Wales are joined to merino rams. However, of the total number of ewes in the region that are joined to non-merino rams a considerable proportion are joined to a maternal sire breed, Border Leicester. This is demonstrated in Figure 26 below.

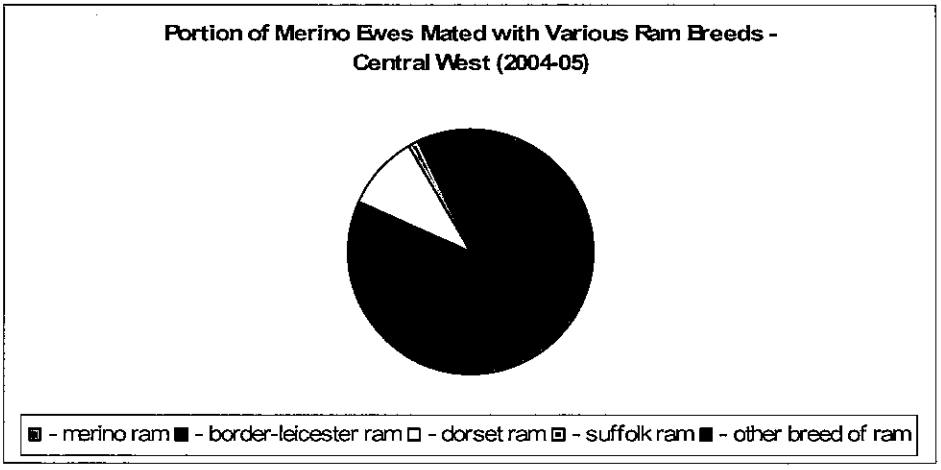


Figure 26 – Portion of Merino Ewes Mated with Various Ram Breeds – Central West Region

Observations

Reproduction efficiency is determined by a range of factors that occur throughout the reproductive cycle. Unfortunately, the only industry-wide data that exists relating to reproduction efficiency is average marking rate which is collected by the ABARE Farm Survey process on a regional enterprise level. It is not possible from marking rate data to determine where in the reproduction cycle losses are most prominent.

As measured by average marking rate, there is no evidence of an industry-wide improvement in reproduction efficiency in the Australian sheep industry as the average marking rate has remained constant at approximately 77 percent over the past 15 years. There is a difference in average marking rate over the past 15 years between enterprise sectors, ranging from approximately 85 percent for prime lamb enterprises to approximately 71 percent for sheep specialists. However, the average marking rate within each sector has varied on an annual basis within a range of only 10 percent in the case of prime lamb and mixed sheep enterprises and approximately 15 percent in the case of sheep specialist enterprises. Average marking rates in all three sectors are approximately the same in 2005 as they were in 1990.

Despite the consistency in industry and sector averages, there does appear to be considerable variation in reproductive performance of flocks both within and between specific regions. For the period 1990-2000 42 percent of regional enterprise sectors achieved average marking rates in excess of 80 percent. However they were confined to 12 AAGIS regions located exclusively in the high to medium rainfall areas of south east Australia. If we compare this data to the average marking rates for the period 2001 to 2005, we find that the total number of regional enterprise sectors that have achieved average marking rates in excess of 80 percent has increased slightly to 46 percent of all regional sheep enterprise sectors and that those enterprise sectors came from a total of fourteen AAGIS regions. However, there has been a considerable skew within the set of regional enterprise sectors that were already achieving average marking rates in excess of 80 percent toward even higher average marking rates, albeit that the improvement in most cases is marginal.

Regional enterprise sectors that have achieved improved average marking rate seem to share three common attributes:

- They are located in areas where agronomic and climatic conditions are more conducive to improved reproduction performance;

- They are located in areas that have a higher distribution of cross-bred and non-merino ewes that typically demonstrate stronger maternal traits than pure-merino ewes; and

- The majority (80 percent) were prime lamb specialists, which is not surprising given that the business model for prime lamb specialists is more likely to respond positively to improve reproduction efficiency.

Innovation in Sheep Reproduction Management

As is indicated by the subject index of the International Journal of Sheep and Wool Science in Figure 24 below, most research in the area of sheep reproduction occurred prior to the 1990s.

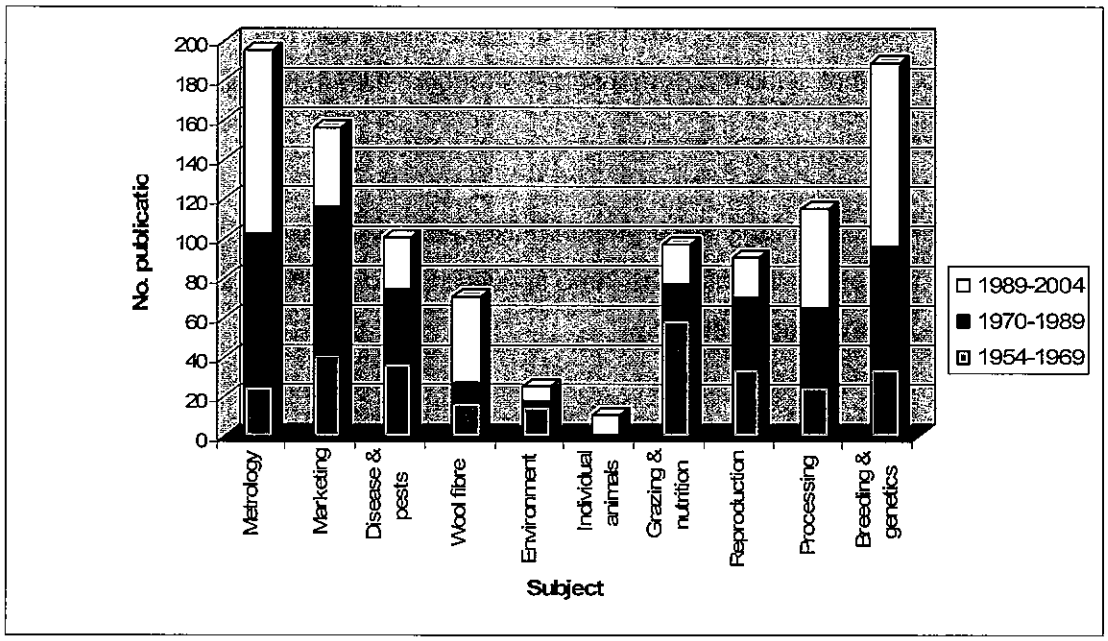


Figure 27

Much of what is being promoted currently as best practice represents the outputs of this pre-1990 work.

Current Status of Science Relating to Sheep Reproduction

During the early 1980s there was considerable activity in sheep reproduction science and extension. The Department of Primary Industries, Victoria and New South Wales, in particular operated a reasonably significant program that covered:

- Effects of increasing the bodyweight of ewes prior to lambing
- Using progesterone priming to stimulate ewes to join in March and lamb in Autumn
- Fecundity

- 'Ram Effect'

Practices revolving around the 'Ram Effect' were probably the most utilized output from this work, as the extension of this practice coincided with increasing use of artificial insemination. The ewe bodyweight work received some take-up, although this was prohibited to a degree by the low price of lamb at the time. Progesterone priming failed to achieve adoption due to the labour intensive nature of its practical implementation. Because the prime lamb industry's focus at the time was on improving carcase quality rather than the number of lambs, funding was withdrawn from most reproduction programs by the mid 1980s.

Through the 1990s, there was very little R&D conducted in the area of sheep reproduction, other than perhaps some projects in Rutherglen that focused on shelter and microclimate during lambing. However, the combination of higher lamb prices and greater demand for Australian lamb in recent years has made efficient reproduction a pertinent issue for industry.

The main sheep reproduction projects that have been operating in Australia since the early 2000s are LAMBMAX and Lifetime Wool. Additionally, there are some small related projects such as the CRC for Dry Land Salinity's work on edible shelter.

An investigation into the status and potential for improvement in sheep reproduction in Australia was commissioned by Meat and Livestock Australia and South Australian Research and Development Institute in 2002[4]. The following Table 7 summarises the main findings of this investigation.

[4] Walker, S., Kleemann, D. and Bawden, S. (2003). *Sheep Reproduction in Australia: Current Status and Potential for Improvement Through Flock Management and Gene Discovery,* Meat and Livestock Australia and South Australian Research and Development Institute.

Area of Investigation	Findings
Effects of nutrition on reproduction from germ cell to lambing Many factors affect the reproductive cycle, but it is claimed that nutrition is the most important factor. Furthermore, the six stages of the reproductive cycle have different nutritional requirements for optimal results.	• Nutrition is the master regulator of reproductive performance by virtue of it exerting effects through the six phases of the reproductive life-cycle – development of the fetal ovary, the pre-antral follicle, the antral follicle, the pre-ovulatory follicle, the early embryo and the pre-implantation period. • There are different nutritional requirements during these phases with high nutrition improving fetal ovarian development and the number of growing follicles in the adult and low nutrition improving the quality of the oocyte and embryo as well as implantation rates. • Nutritional requirements during pre-antral follicle development are not known and it is hypothesized that nutrition in this period sets the nutritional requirements for subsequent development. • The feeding of high protein diets can result in the production of excess ammonia which is embryo toxic and which can pervade all components of the reproductive tract. High protein diets must be balanced with energy content. • It is speculated that high embryo wastage and partial failure of multiple ovulations (PFMO) following high dietary intake is due, partly or wholly, to the production of excess ammonia. • The physiological means whereby nutrition influences reproduction is not known. However, the insulin – GH-IGF1 axis is strongly implicated. • The role of BCAA as a physiological link between nutrition and ovulation rate requires further investigation with emphasis on ovum quality.
Effects of environment on reproduction from germ cell to lambing Environmental factors can affect reproductive performance and these factors operate on a local or regional basis.	• The 'Ram Effect' can induce and increase the frequency of oestrus. • Heat stress can cause abnormal patterns in the occurrence of oestrus, elevated levels of embryo mortality and aberrant patterns of fetal growth. • Environment toxins resulting from the use of herbicides and pesticides have the potential to seriously reduce reproductive performance. • Consumption of phyto-oestrogens by sheep in the higher rainfall areas of the country can cause a significant reduction in lamb marking percentages. • Poor seasonal conditions can result in low ewe liveweight and fat scores at time of joining, both of these factors affect ovulation rates.

Area of Investigation	Findings
Genetic and epigenetic control of reproduction from germ cell to lambing Selection of genetic traits for reproduction is note widely practiced, mainly because of the logistical challenges associated with measuring the desired traits. This is an interesting observation given that superior maternal genetics has been cited as a major contributor to the strong reproductive performance of the New Zealand industry. As such, the resistance is most likely also a product of a reluctance of a predominately wool industry to introduce genetics that might broaden fibre width.	• Reproductive traits are moderately heritable and selection programs have produced annual responses of up to 1.5 percent in the number of lambs born each year. • Selection programs with reproduction goals should be used to complement optimal nutritional and animal management practices in order to achieve the best results.
Neonatal mortality and early growth Nutrition and management practices can have a significant influence on lamb survival. Nutritional strategies focus on understanding the relationship between mortality and birthweight.	• Size of the placenta, under most circumstances, determines growth of the fetus and varying strategies to generate normal placenta are indicated. • Nutritional requirements of ewes supporting multiple fetuses differ substantially from those carrying singles. • Minimal disturbance of the ewe and her lambs is required to establish a strong bond between mother and offspring and this is the key principle governing the development of successful lambing systems. • Choice of lambing paddocks with features conducive to enhancing the microclimate of new born lambs should reduce lamb losses that result from cold exposure. • Relationships between stocking density, frequency of ewes lambing, litter size and paddock size per se and neonatal loss are not well understood. • Promising indirect selection criteria have been proposed for improving lamb survival but need further development for widespread adoption by the industry. • Strategic baiting programs may control primary predation. • The most efficient management tools to meet the high nutritional demands of the breeding flock are to match the animal's nutrient requirements with pasture availability, adjustment of stocking rate and attention to major factors governing pasture growth and quality. • Devising nutritional systems for maintaining adequate lamb growth rates when pasture quality declines, amelioration of grass seed problems and control of internal parasites are the major factors that need to be considered during the post weaning period.

Table 7 – Summary of 2002 Review of Australian Sheep Reproduction Science

The report also made a series of recommendations relating to the use of differential nutrition strategy and certain management practices during the reproductive cycle. These are summarized in Table 8 below.

Differential Nutrition Strategy	Management of Flock Mating
• Low nutrition during the first two weeks of pregnancy to improve embryo survival rates due to an increase in plasma progesterone concentrations. There is a linear relationship between feed intake and progesterone concentration and it is recommended that ewes be fed at 0.9-1.0M diet. • After the first two weeks of pregnancy, the diet is gradually increased to 1.3-1.5M by mid pregnancy. This diet ensures timely commencement of meiosis in the fetal ovary, proper development of the fetus and improved oocyte quality in resultant offspring. • Nutrition should remain high (e.g. 1.5M) during the first half of the pre-antral period given it most often coincides with lactation. Follicles that develop are those that will ultimately generate ova for the production of the next generation. It is postulated that the level of nutrition should be gradually reduced mid-way through the pre-antral period to reach 0.8-0.9M towards the end of this period. It is hypothesized that the size of the pool of growing follicles is increased and that the quality of the oocytes is improved through this strategy. • Nutrition should be gradually increased as the ewe enters the antral phase of follicle development, rising from 1.0M diet late in the pre-antral period to 1.5M midway through the antral period. Alternatively, a high protein diet can be fed late in this phase. • The level of nutrition should be gradually reduced from the middle of the antral period to reach 1.0 during the five day period in which the pre-ovulatory follicle develops to the point of ovulation. This maximizes the likelihood of ova of high quality being produced with downstream benefits in terms of both embryo quality and a reduction in the incidence of PFMO. • Ewes should continue to be exposed to a low nutrition level (e.g. 0.7M) during the first three to five days of embryo development to improve embryo quality. This period of low nutrition is then extended to cover the first two weeks of pregnancy as outlined above.	• Application of a nutrition strategy that meets the requirements of each stage of the reproductive cycle will offer opportunities to increase ovulation rate, reduce embryo mortality and increase implementation rates. In flock mating, where there is not synchrony of ovulation, the implementation of such a strategy may prove problematic • Successful application of the strategy is more likely when mating occur in summer or autumn when it is easier to regulate flock nutrition than in spring when paddock nutrition is generally high • Reproductive performance of any one animal in any year will reflect the life-time cumulative benefits provided by the differential strategy, given that the strategy is ideally implemented from the time of embryo development and continues throughout the lifetime of the animal • Overweight animals, particularly those on a rising plane of nutrition, are reproductively inefficient • A better awareness of the seasonality of the flock will enable maximum flexibility in situations such as drought where early lambing might be desirable • A better understanding of the ram effect will minimize risks associated with ewes re-entering anoestrus during the mating period • Pasture assessment in high rainfall areas for the presence of oestrogenic clovers is strongly recommended

Table 8 – Recommendations from 2002 Australian Sheep Reproduction Review

In 2006 an additional review of sheep reproduction science relating to management options to improve the performance of merino ewes was undertaken by the Department of Agriculture and Food, Western Australia on behalf of MLA and AWI. This report found that since 2002 research in the sheep reproduction area has been undertaken in the following institutions: University of Sydney, CSIRO, University of New England, Charles Sturt University, Meat Science Australia, SARDI, DPI Victoria, University of Western Australia, Department of Agriculture and Food Western Australia and DPI Queensland. Such research has focused on the following issues:

- Sources of losses
- Increasing reproductive efficiency with ram effect and enhanced colostrum production.
- Shearing in mid-pregnancy
- The physical environment at lambing
- Disturbances during lambing
- Colostrum production
- Foetal programming and ewe performances
- Genetic correlations between reproduction, wool production and fat levels
- Behaviour and genetic selection

Both investigations make recommendations as to priority areas for future sheep reproduction research. These are demonstrated in Table 9 below.

2002 Review Recommended Priority Areas for Future Research	2006 Review Recommended Priority Areas for Future Research
• Nutrition during the development of the pre-antral follicle • Partial Failure of Multiple Ovulations (PFMO) • Energy and protein components of the diet • Dietary determinants of embryo quality • Demonstration of the benefits of the differential nutrition strategy	• Timing of embryo losses and the level of lossess and development of strategies to minimize mortality • Development of strategies to improve the viability of fetuses and to optimize the environment for effective foetal programming • Development of strategies to maximize the survival of newborn lambs • Determine the influence of genotype on the various reproductive parameters • Management issues that influence the reproductive performance of sheep e.g. stocking rates, times of lambing, targeted feeding etc • Development of on-farm management packages with the potential to improve the reproductive performance of ewes from a range of different environments and circumstances

Table 9 – Recommendations from 2002 and 2006 Reviews of Sheep Reproduction

Observations

Three key observations can be made from an analysis of innovation in sheep reproduction:

- It would seem, according to publications in a major sheep industry scientific journal that the vase majority (approximately 80 percent) of innovation in the area of reproduction occurred prior to 1990. According to the same analysis, at least half of the innovation in sheep genetics has occurred post 1990. As such, most of the non-genetics based management practices designed to improve reproduction performance have been in existence and available to industry for at least a decade and in some cases a lot longer.

- Best practice as promoted by science consists of a large range of practices that mostly offer incremental improvements and increased precision rather than a set of practices that offer a clear significant benefit in a given production environment

- An economic case for managing for optimal reproduction performance has not been produced either generically or for specific production environments and goals.

Extension of Sheep Reproduction Best Practice Management

This section provides details on various agricultural extension programs that are targeted at sheep industry participants across the southern agricultural region of Australia. The programs that are discussed below have been selected on the basis that part of their content is designed to increase awareness and transfer knowledge relating the best practice management of reproduction efficiency, albeit that in many cases, reproduction efficiency is a relatively small component of the overall content of the specific program.

Extension programs that are relevant to the area of sheep reproduction efficiency are funded by Meat and Livestock Australia, Australian Wool Innovation or one or more of the individual State Departments of Primary Industries or by co-funding arrangements between the organizations. Figure 28 overleaf demonstrates the main extension programs that deliver content relating to sheep reproduction, their geographical target and their primary funding arrangements.

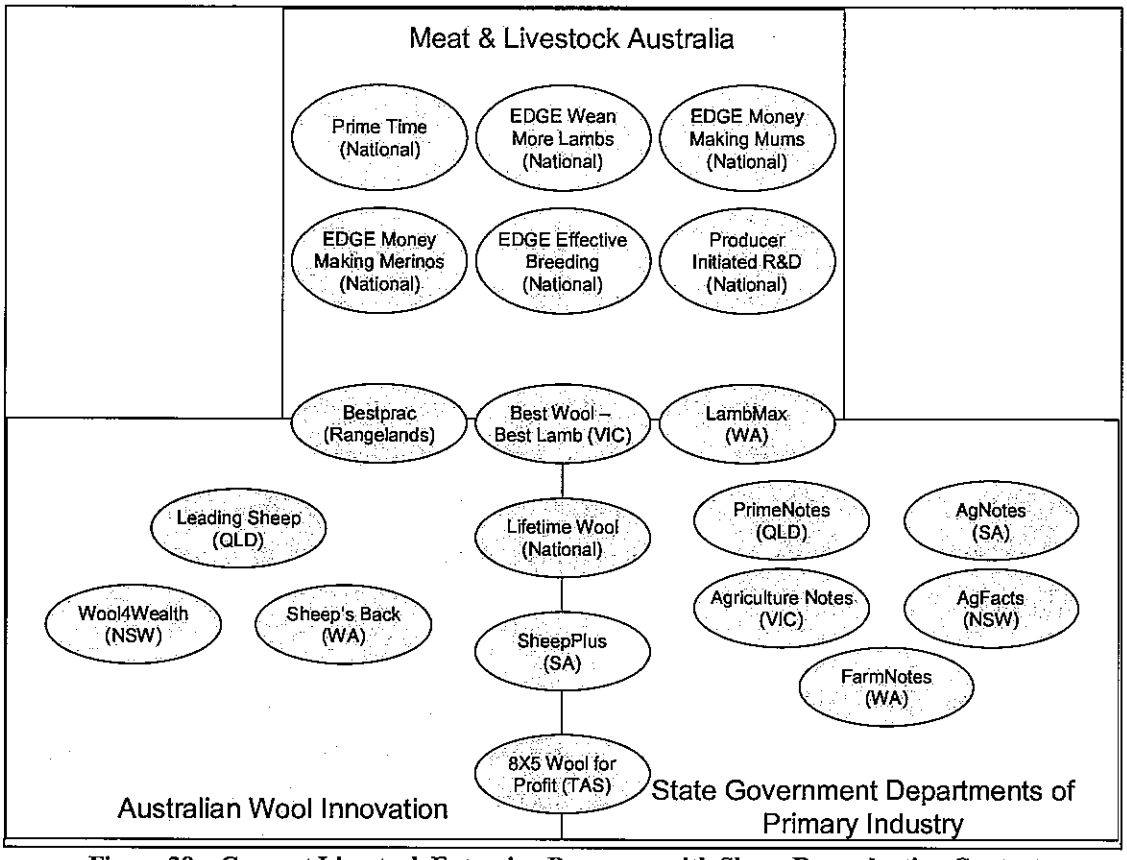


Figure 28 – Current Livestock Extension Programs with Sheep Reproduction Content

Sheep reproduction management practices are also taught in more formal agriculture courses delivered by TAFE, agriculture colleges and university agriculture faculties. However, this review is focuses solely on the extension programs described in figure 28.

Extension Programs Funded Primarily by Meat and Livestock Australia

Meat and Livestock Australia (MLA) funded extension activities are primarily managed under either the umbrella of its Prime Time or EDGE Network programs or through Producer Initiated Research and Development Schemes (PIRDS). The Prime Time forum Program is designed to raise awareness of best practice in a range of issues associated with livestock management among livestock producers in Australia. It also involves a number of support workshops that are delivered to Elders and Landmark clients. However, the more structured extension programs that are funded by MLA are

coordinated under the MLA EDGE Network program. PIRDS are small grants provided to groups of producers for specific research and development activities.

Prime Time Forums

Launched in 2002, Prime Time is a broad industry awareness campaign designed to raise awareness among producers of improved genetics, nutrition and management practices for sheep and prime lamb production, in order to drive an increased supply of lamb and sheep meat suitable for domestic and important overseas markets. Over 5,000 producers and breeders have attended the Prime Time program, representing approximately 30 percent of Australian prime lamb producers or 9 percent of sheep producers in Australia.

Each Prime Time Forum is delivered over a single day in the form of a series of presentations from a range of industry experts. Forums are typically held at either a livestock property or rural centre. Although the cost of delivering individual forums is unclear, the budget for the delivery of the Prime Time Program is around $300,000 per annum. To date, the Prime Time forum program has been delivered over three phases:

- The first year's activities were targeted at sheep and lamb producers located in the Sheep and Cereal Zone with a view to shifting focus away from cropping and back to sheep production,
- The second year's activities focused on Merino producers, promoting the future opportunities for prime lamb production, and
- The third year's activities were targeted prime lamb producers with a view to changing their focus from increasing the number of lambs produced, to improving yield and leanness.

Prime Time forums present a range of topics that may include elements of sheep reproduction management. For example, the Prime Time Prime Lamb forums focused on increasing lamb survival rates and improving financial returns from lamb production enterprises, of which reproduction efficiency is a major factor. Table 10 below demonstrates locations where Prime Time Prime Lamb forums have been delivered.

Prime Time for Lamb Forums AAGIS Region	Number of Groups
South East	2
Gippsland and Western Districts	2
Central North	2
Central and Southern Wheatbelt	2
South West	1
Central West	1
Darling Downs	1
New South Wales Tablelands	1
Northwest Slopes and Plains	1
Riverina	1

Table 10 – Geographical Location of Prime Time Forums

Prime Time is evaluated through exit surveys of all participants that measure awareness of Prime Time, reactions to Prime Time content, intentions to make practice changes, and requests for further information on EDGE, Sheep Genetics Australia (SGA), MLA supply chain management, MLA membership and the Lamb Cost of Production calculator.

Although practice change is not the main intention of the Prime Time Program, exit and follow-up surveys do attempt to ascertain the impact of participation in forums. An exit survey of 1,428 participants in the Prime Time for Prime Lamb Forums reported that 89 percent of respondents believed that they would make practice changes as a direct result of attending the forum. Respondents identified the following intended practice changes related to improving reproduction efficiency:

- Improving ewe nutrition and condition score,
- More strategic feeding of lambs, and
- Modify/review lambing and joining times.

A follow-up survey of 220 Prime Time Forum participants[5] reported that eighty-one percent of participants had made some practice changes as a direct result of participating in Prime Time forums. Forty-two percent of respondents changed reproductive management practices, 33 percent changed time of lambing or weaning, 42 percent changed genetic selection practices and 17 percent changed management or preparation of sires. Thirty-eight percent of respondents sought additional information after the workshop before they made changes to their management practice. However, an absence of information as to the precise nature of these practice changes, the extent of change and the impact of change on the sheep enterprise make it difficult to determine the effectiveness of the Prime Time forums at effecting meaningful practice change in the area of sheep reproduction efficiency.

A central aim of the Prime Time Forum program is to generate interest among participants in relevant Prime Time and EDGE Network workshops. Requests for further information about workshops are captured in forum exit surveys. For example, 657 attendees at Prime Time Prime Lamb forums requested information on the Wean More Lambs EDGEnetwork workshop, suggesting that the Prime Time Prime Lamb forums were reasonably successful in creating awareness and motivating its audience to seek further information on reproduction management best practice.

Prime Time Workshops

Prime Time workshops, initiated in 2005, are full or half day workshops aimed at developing skills in targeted livestock management practices. Prime Time workshops are marketed through Prime Time forums and Elders and Landmark and are delivered with the support of DPIs, AWI and private consultants. Elders and Landmark agents are able to invite around 20 producer clients to participate in the structured workshops on topics of specific relevance to their enterprise that they may have identified from the Prime Time Forums. Prime Time workshops are either free of charge or involve a token charge for the participant. The individual workshops do not have a specific budget.

[5] Logan, J. (2005). *Meat and Livestock Australia Program Adoption & Awareness Survey,* Prepared by Axiom Research for Meat and Livestock Australia.

There are currently four half day Prime Time follow-up workshops two of which focus specifically on reproduction management:

- *Ewe and weaner management*

  This workshop is based on the concept that lamb weaning rates can be improved by applying specific ewe management practices during Autumn. The content covers techniques for condition scoring ewes, developing a feed budget, improving nutrition, animal health and water.

- *Maximising reproductive performance*

  This workshop is based on the concept that providing ewes with the appropriate nutrition at different times in the year will result in improved weaning rates. The workshop provides producers with effective techniques for assessing the nutritional requirements of rams and pregnant ewes and developing an appropriate nutrition program. Workshop content covers assessing the condition of ewes, the impact of feed quality and quantity on animal performance, ram management and joining strategies, determining the quantity and quality of supplements, developing a feed budget for managing ewes through summer and autumn and managing and preventing diseases that impact on reproductive performance.

Table 11 overleaf demonstrates the locations of Ewe and Weaner Management and Maximising Reproductive Performance workshops to date. The specific number of participants in individual Prime Time Ewe and Weaner Management and Managing Reproductive Performance workshops is not available. However, at approximately 20 participants per workshop over eight workshops, total participation can be estimated at around 160 producers.

Ewe and Weaner Management		Maximising Reproductive Performance	
AAGIS Region	Number of Workshops	AAGIS Region	Number of Workshops
New South Wales Tablelands	2	Wimmera	1
Central West	1		
Central Northern	1		
South East	3		

Table 11 – Geographical Location of Ewe and Weaner and Maximising Reproductive Performance Workshops

Prime Time workshops are typically evaluated using exit and follow-up surveys of participants. An evaluation of the Managing Reproductive Performance workshop was undertaken using an exit survey sample of 15 participants. This survey reported that reactions to the workshop by participants were very positive. The survey evaluated practices demonstrated in the workshop in terms of what was already used by participants, what practices participants felt more confident in using as a result of the workshop and what practices participants intended to use as a result of attending the workshop. Responses relating to increased confidence in specific management practices were strong; however responses relating to whether interviewees would definitely use specific practices in the future ranged from only 20 to 48 percent of interviewees.

An evaluation of the Ewe and Weaner Management workshop was undertaken using an exit survey sample of 33 participants. This survey reported that reactions to the workshop were very positive. Again, the survey evaluated practices demonstrated in the workshop in terms of what was already used by participants, what practices participants felt more confident with as a result of having attended the workshop and what participants would use as a result of attending the workshop. As with the surveys relating to the Reproduction Effectiveness Workshops, responses relating to increased confidence were strong but responses relating to whether the interviewees would definitely use the practices in the future ranged from only 36 to 48 percent. It is not clear from the evaluation what precise practice changes participants intended to make as a result of participation in the workshops and the potential impacts on reproduction management that could be attributed to those practice changes.

EDGE Network

EDGE*network*® (EDGE) is an extension and producer training initiative developed and funded by MLA and delivered by its partners since 2000. The goal of EDGE is to provide a nationally coordinated industry learning system that enables livestock producers to face the future with confidence in their ability to improve production efficiency, natural resources and the family business. EDGE is comprised of a series of structured workshops delivered across Australia to meat and livestock producers (sheep and beef) through private and public state licensees. EDGE is one of MLA's main extension vehicles for communicating research outcomes that target improved profitability and sustainability of meat and livestock enterprises.

EDGE delivers around 50 subject specific workshops to Australian meat and livestock producers and employs a structured workshop approach with programs ranging from between one and three days. EDGE workshops are typically delivered on a participant's stud or farm.

EDGE workshops provide specific technical information, peer learning, integrated practice change and enterprise development and are targeted at producers that perhaps lack technical knowledge and prior competence in a specific subject area, but have the desire to improve their enterprise and the willingness to adopt new management practices in order to achieve improvements.

The total MLA investment in EDGE from initial development and piloting in 1998/99 to date is approximately $3.7 million. In 2005-06 it cost approximately $1million to administer the EDGE program. To date some 1,945 sheep producers have participated in EDGE workshops relating to sheep reproduction efficiency, representing approximately 12 percent of prime lamb producers or 3 percent of Australian sheep producers.

EDGE is priced on the basis of internal cost recovery plus the cost of the external deliverer. The cost to participants varies from $750 to no charge depending upon the level of local support from programs such as FarmBis. Ninety-seven percent of 220

EDGE participants surveyed thought that EDGE workshops represented value for money.

Initially, EDGE workshops were designed using basic adult learning principles with the workshop structure content and delivery mechanism audited to ensure compliance with these principles. While the audits do not appear to have been conducted consistently in recent years, anecdotal evidence suggests that for the most part workshop are designed and delivered using adult learning principles.

The targeting of participants for EDGE is relatively *ad hoc*. The EDGE program is heavily promoted at Prime Time forums. However, participants in EDGE workshops tend to be the clients and associates of workshop deliverers. As such, the EDGE audience is typically comprised of stud breeders and their commercial sheep producer clients and stock agents and their commercial sheep producer clients.

In terms of program evaluation, workshop exit surveys are employed to capture participant's immediate reactions to the workshop. *Post hoc* interviews are also undertaken with a sample of participants to generate testimonials for program marketing. Evaluations of EDGE workshops have tended to focus on program design and review rather than the measurement and analysis of impact and practice change. Pilot workshops are evaluated using participant observation during the workshop, structured interviews post workshop, and unstructured discussions with participants during the workshop.

There are four workshops within the EDGE program that promote and extend improved sheep reproduction efficiency practices:

1. Effective Breeding Lambs (now called Terminal Sire Selection)
2. Wean More Lambs
3. Money Making Merinos
4. Money Making Mums

Historical producer participation in the reproduction efficiency focused workshops is demonstrated in figure 26 below.

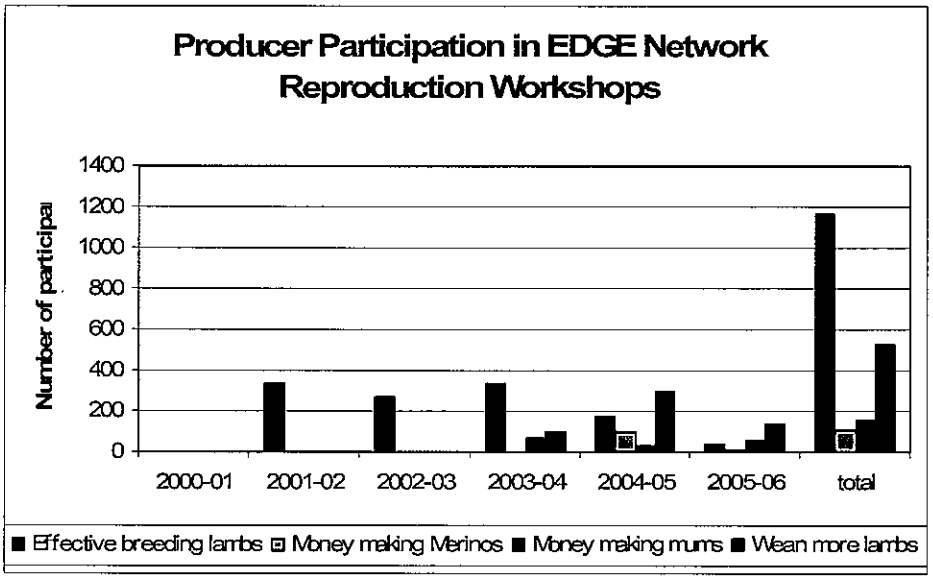


Figure 26 – Producer Participation in EDGE Network Reproduction Workshops

There has been a total participation in EDGE Network workshops that have a reproduction component of 1,945 producers. According to the preliminary assessment of the specific EDGE workshops below, the EDGE workshops that address issues associated with reproduction efficiency have influenced the reproduction management practices of approximately 750 producers, or 38 percent of the participants in those workshops. This equates to 1.3 percent of Australian sheep producers or 5 percent of prime lamb producers.

Table 12, below, identifies the number and location of EDGE workshops relating to improved reproduction efficiency. However, this data is incomplete as record keeping for EDGE appears to be dispersed among delivery partners.

	Effective Breeding Lambs	Wean More Lambs	Money Making Merinos	Money Making Mums (data not available)
Workshop Location (AAGIS Region)	Number of Workshops			
Eyre Peninsula	2	3	2	
Northern Tasmania, Huon and Midlands		1		
Mid North and Murraylands		2		
South East			1	

Table 12 – Geographical Location of Sheep Reproduction Focused EDGE Network Workshops

The content, historical participation and adoption effectiveness of these reproduction focused EDGE workshops are described in detail below.

1. Effective Breeding Lambs (now Terminal Sire Selection)

The Effective Breeding Lambs/Terminal Sire Selection workshop is designed to transfer knowledge relating to improved ram selection and the development of breeding strategies. This workshop focuses on the use of genetics to meet production requirements for the lamb market. There is little content relating to the selection of maternal sires. Specific workshop content includes:

- Identifying the desired breeding gains for the producer's own situation, while giving consideration to target markets and environmental constraints,
- Considering the options to achieve the producer's desired changes using genetics, and
- Developing strategies relevant to the producer's own operations which optimize genetic gain.

1,162 producers have completed the workshop since its launch in 2001-02, representing approximately 7 percent of prime lamb producers or 2 percent of Australian sheep producers.

This workshop has been evaluated for impact through an interview survey of 33 participants. The evaluation reported the following practices changes as a result of attending the workshop:

- 44 percent changed reproductive management practices,
- 22 percent changed time of lambing or weaning,
- 26 percent changed genetic selection practices,
- 22 percent changed management or preparation of sires, and
- 34 percent of participants sought further advice or information after the workshop, prior to implementing practice changes[6].

Based on an extrapolation of the evaluation interview data, it can be estimated that this program influenced the reproduction management practices of approximately 500 participants, or 3 percent of prime lamb producers or 1 percent of Australian sheep producers. However, there are no details of specific practice changes relating to reproduction management adopted by participants or the extent of those changes in the evaluation report.

2. EDGE Network: Wean More Lambs

This workshop is focused specifically on improving reproduction efficiency in a sheep enterprise. Specific workshop topics include:

- Determining the value of optimizing sheep reproduction in the enterprise,
- Identifying the important on-farm tasks that relate to the management of nutrition for reproduction performance,
- Determining which factors contribute to reproductive wastage in sheep flocks,

[6] Logan, J. (2005). *Meat and Livestock Australia Program Adoption & Awareness Survey,* Prepared by Axiom Research for Meat and Livestock Australia.

- Specific skills required to increase flock reproductive performance including, fat scoring to determine probability of dry or lost lambs, identifying singles or twins, checking ram health, identifying 'wet and dry' ewes, utilization of green feed in spring, using the ram effect and predator control, and
- Developing an annual calendar of activities to optimize flock reproductive capacity.

MLA and NSW DPI have produced a *Wean More Lambs: Optimising Sheep Reproductive Performance* booklet that complements this EDGE workshop. The booklet describes best practice for reproduction management.

Approximately 528 participants have completed the workshop since its launch in 2001-02, or 3 percent of prime lamb producers or 1 percent of Australian sheep producers. In an interview survey of 37 workshop participants the following responses to the workshop were reported:

- 84 percent participants changed practices as a result of the program,
- 28 percent changed reproductive management practices,
- 34 percent changed time of lambing or weaning,
- 19 percent changed genetic selection practices, and
- 16 percent changed management or preparation of sires.[7]

Based on the interview sample size of 37 workshop participants, it can be estimated that this workshop has influenced the reproduction management practices of approximately 150 producers, or 1 percent of prime lamb producers or less than 0.5 percent Australian sheep producers. However, a detailed examination of practice changes in sheep reproduction affected by this workshop has not been undertaken nor does any benchmarking data of workshop participants exist.

[7] Logan, J. (2005). *Meat and Livestock Australia Program Adoption & Awareness Survey,* Prepared by Axiom Research for Meat and Livestock Australia.

3. EDGE Network: Money Making Merinos

This workshop is designed to transfer knowledge relating to improving the genetic value of Merino ewes by developing knowledge and skills relating to:

- Identify the importance of Merinos in both wool and meat enterprises,
- Determining the key factors that drive profit including the importance of lambing rate in livestock trading value,
- Practices for increasing lambing rate,
- Identify the genetics that are important to prime lamb production,
- Setting production targets and developing an action plan for the enterprise,
- Calculate the value of EBVs within a real life situation,
- Using EBVs to select a ram,
- Investigating the impact of genetic changes on management practices, and
- Evaluation of contract breeding.

107 participants have completed this workshop since its launch in 2001-02, representing 0.5 percent of prime lamb producers or less than 0.5 percent of Australian sheep producers. Sixty-three percent of participants reported practice change as a result of participating in this workshop.[8] Participants in the pilot study of this workshop found it useful and 60 percent indicated that the workshop had provided them with new information. Participants identified applicable knowledge about ram selection, researching ram breeding figures, improving returns from wool and prime lambs and becoming a member of SGA as being applicable to their own practices. Based upon the evaluation of the pilot workshop we can estimate that this workshop has affected the reproduction management practices of approximately 50 producers. However, a detailed examination of practice changes in sheep reproduction has not been undertaken nor does any benchmarking data for participants exist.

[8] Logan, J. (2005). *Meat and Livestock Australia Program Adoption & Awareness Survey,* Prepared by Axiom Research for Meat and Livestock Australia.

4. EDGE Network: Money Making Mums

The content of this workshop is designed to assist sheep producers to increase the genetic value of cross bred ewes. This one-day workshop is delivered by sheep breeding specialists to small groups using hands-on ram demonstrations, the presentation of theory, group discussions and individual activities. 148 producers have participated in this workshop since its inception in 2003-04, representing 1 percent of the prime lamb producers or less than 0.5 percent of Australian sheep producers.

In an interview survey of 17 workshop participants, the following responses to the workshop were reported:

- 67 percent participants reported practice change,
- 36 percent changed reproductive management practices ,
- 7 percent changed time of lambing or weaning,
- 43 percent change genetic selection practices,
- 29 percent changed management or preparation of sires, and
- 56 percent of participants sought further advice or information after the course and prior to implementing practice change.

Based on the above interview assessment, this workshop has influenced the reproduction management practices of approximately 50 producers.

In 2005 an evaluation of the effectiveness of EDGE was commissioned by MLA[9]. A random sample of 220 EDGE participants from a total of over 4000 were interviewed as to the impact that EDGE participation had on their management practices. While the analysis of these interviews does not describe actual practice changes, the extent of actual changes or outcomes experienced as a result of making those changes, it does provide an overview of outcomes. 148 of those surveyed identified themselves as sheep/lamb producers and 52 percent of interviewees had attended a livestock EDGE workshop. Of those surveyed 17% (37) had attended Wean More Lambs, 15% (33) Effective Breeding Lambs and 8% (17) had attended Money Making Mums EDGE

[9] Logan, J. (2005). *Meat and Livestock Australia Program Adoption & Awareness Survey,* Prepared by Axiom Research for Meat and Livestock Australia.

workshops. As a result of attending these EDGE workshops 24 percent of interviewees changed reproductive management practices, 17 percent changed time of lambing or weaning, 8 percent changed management or preparation of sires, and 13 percent changed genetic selection practices.

Producer Initiated Research and Development (PIRDs) Focusing on Sheep Reproduction

Producer Initiated Research and Development Schemes (PIRDS) are producer managed 'R&D' programs based on new science being introduced to the industry by MLA. They serve as a useful channel to get early adopters using and developing an innovation for commercial needs. The basic concept revolves around a group of aligned producers, supported by MLA, using and adapting a new innovation into a commercially valuable product or practice. The vast majority of PIRDS that relate to sheep reproduction have focused on the application of maternal genetics, breeding and animal selection. Table 13 below demonstrates historic and current PIRDS that relate to reproduction efficiency.

PIRD Manager and Location	PIRD	Description
Heywood Advanced Breeders Group	US Suffolk Ram Lambs	Located in Portland, Victoria, the aim was to develop a breeding program incorporating USA Suffolk genetics into its prime lamb seedstock
Beacon Prime Lamb Producer Group	Crossbred Ewes may Flourish in WA	Located in the South West of Western Australia, the aim was to evaluate Finn x Merino and Border Leicester/Booroola x Merino crossbred sheep for sheepmeat production and develop management systems using legume crops and stubbles for sheepmeat production.
Campaspe & Elmore Field Day Prime Lamb Group	Lamb Production	Located in Elmore, Victoria the aim was to demonstrate the financial returns from purchasing high EBV rams, provide information on the pros and cons of first cross lamb dams (Border Leicester x Merino) compared to large framed Merino dams and practically demonstrate the use of Prograze and Wormplan.
Mount Gambier Prime Lamb Group	Comparison of Highly Fertile Ewe Crossbreeds	Located in Mt Gambier, South Australia, the objectives of this program were to determine whether ewes with East Fresian or Booroola Leicester backgrounds crossed with Merinos demonstrate advantages for prime lamb enterprises over the traditional Border Leicester x Merino ewe, to learn about the differences in management of highly fertile ewes, compared with Border Leicester x Merino crossbred ewes and identify potential issues, to compare the physical attributes between the different ewe genotypes that are relevant to prime lamb production and to estimate the lamb live weight and lamb carcase averages on a per hectare basis.
Border Leicester Association ($uperBorder$	Improving Maternal Genetics	Located in Deniliquin, New South Wales, the objectives of the project were to establish if Border Leicester rams that are suitable for the program and may ben labeled as $uperBorder$, establish a register of sources and quantity of supply of Border Leicester rams which meet the agreed performance criteria, determine demand for first cross ewes

PIRD Manager and Location	PIRD	Description
		bred from $superBorder$ and their market criteria and establish a network of first cross breeders who wish to supply this demand, determine ways they will meet the market criteria and detail the means they will use to market their product.
WA Q-Lamb Inc	Benchmarking Maternal Sheep Breeds for the Production of Large Lean Sucker Lambs in WA	Located in Badgingarra, Western Australia, the aim of this project was to provide Q-Lamb members with an objective demonstration of new and current maternal genetics, among maternal breeds, to produce quality heavy weight sucker lambs, to evaluate ewe breeds as mothers of sucker lambs in Western Australia, conduct an independent evaluation of two new sheep breeds in Western Australia (East Fresian and South African Meat Merino) and demonstrate the financial benefits of using first cross rams over Merino ewes to produce second cross sucker lambs.
Super Ewes-More Lambs	Improving Prime Lamb Profitability	Located in Strathalbyn, South Australia, the aim of this project was to produce high performance, high fertility, worm resistant maternal genetic material through the use of LAMBPLAN and selection for worm resistance irrespective of breed or breed mix (maternal and self replacing) and to develop strategic alliances from maternal sire breeders through crossbred ewe breeders to prime lamb breeders and establish supply and purchase contracts for ewes bred by member's rams under the Super-Ewes brand, primarily in south west Victroria and south east South Australia.
Lower North Lamb Marketing Group	Prime Lambs from Merino Ewes	Located in Kapunda, South Australia, the aim of this project was to help members decide on the most economic flock to produce prime lambs. In particular, to determine the best age at which to buy replacement ewes and to determine from which price bracket to purchase rams.
Mount Gambier Prime Lamb Group	Comparison of Highly Fertile Ewe Crossbreds	Located in Mt Gambier, South Australia, the purpose of this project was to demonstrate the economics of grazing highly fertile crossbred ewes compared with the traditional Border Leicester x Merino ewes. In addition, it is expected that the trial will provide an opportunity to learn practical on farm management skills which are necessary to successfully turn off lambs using high fertility ewes.

Table 13 – Sheep Reproduction Focused PIRDs

Extension Programs Funded Primarily by Australian Wool Innovation

Most of Australian Wool Innovation's (AWI) extension activities are managed under the organisation's National Woolgrower Extension Network, which delivers an extension program in each state. Programs such as the Sheep's Back, Wool4Wealth and Leading Sheep are funded exclusively by AWI and the other programs are funded under a co-investment relationship with either MLA or one or more of the State departments of primary industry. With the notable exception of Lifetime Wool, most of these programs only have a small component that covers sheep reproduction. This section only discusses the programs funded exclusively by AWI.

The Sheep's Back

The Sheep's Back extension program is funded by AWI for $1.1 million over three years, and is delivered by a group of agricultural consultants in Western Australia collectively known as ICON Ag. The Sheep's Back is delivered via coordinated producer groups that are mentored and facilitated by a local consultant. Program content is delivered through a series of workshops. The program is based in Western Australian and targets sheep producers in the wool and sheep-wheat belts, albeit with a bias toward wool producers. Participants are charged $950 (+ GST), and receive a rebate of 50 percent from the FarmBis Program.

The program aims to deliver increased profitability to participating sheep enterprises through a greater understanding of relevant profit drivers, primarily stocking rate. The goal is for participants to achieve a 10 percent average increase in stocking rate and profitability and to reduce the cost of raw wool production by an average of 10 percent.

The program is comprised of nine modules that provide participants with better knowledge of seasons and stocking rates, so that they can capitalize on good seasons with increased stocking rates. The approach is balanced with an innovative risk management tool called 'Back Door'. During the program all participants produce their own farm plans to successfully deal with deterioration of the season when it occurs. The program does explore the economics of improving reproduction, but this accounts for approximately only 5 percent of the overall course content. A module in reproduction management is currently being developed and is planned to be piloted in August 2006.

There are currently 21 Sheep's Back producer groups involving approximately 315 producers. This represents approximately 4 percent of Western Australian sheep producers or 5 percent of non lamb specialists. Participating producers run approximately 2 million sheep, or 9 percent of the total Western Australian flock. The effectiveness of the program is measured by regularly monitoring and benchmarking participants. However as the benchmarking data is confidential and the program is relatively new, it is not possible to report on adoption effectiveness at present.

Wool4Wealth

The Wool4Wealth program is an AWI Ltd funded extension program which targets primarily wool producers operating in New South Wales. This is a self-directed program that exists within a broad framework of management practices. It is a three year course consisting of 12 hands-on professional workshops designed to help build higher productivity and profitability for enrolled wool enterprises. The group selects a consultant and specialist presenters are made available to the groups. In the second year, each business receives a half day on-farm consultancy to look at individual farming issues. The cost to participants is $1155 (GST Incl.) per enterprise.

The program explores the differences that exist between growers in a particular location using benchmarking and largely is largely driven by participants. Topics covered in Wool4Wealth include:

- Comparative analysis of key profit drivers,
- Business planning,
- Optimising stocking rates,
- Increasing lamb numbers,
- Sheep health,
- Using genetics for profit,
- Wool marketing strategies,
- Drought management strategies,
- Succession planning, and
- Grazing management.

Individual groups choose the emphasis of the program from the topics listed above depending on local needs. Reproduction issues usually form part of the program and cover nutrition, abortion diseases, first year lamb survival and a self-assessment to determine where problems exist in reproduction management.

Wool4Wealth has been operating for approximately 2 years. There are currently 15 groups with approximately 12 participants in each group, representing 1 percent of sheep enterprises in New South Wales. In terms of the evaluation of adoption

effectiveness, participants complete an entry survey which measures existing production settings and attitudes. The same survey will be conducted at the end of the program to determine changes in practice. As this program is only two years old, there is no assessment of practice change as yet.

Table 14 overleaf outlines the number of Wool4Wealth groups in each of the AAGIS Regions.

Wool4Wealth	
AAGIS Region	Number of Groups
Riverina	8
Central West	5
New South Wales Tablelands	2

Table 14 – Geographical Location of Wool4Wealth Workshops

Leading Sheep

Leading Sheep is an extension program for sheep producers in Queensland funded by AWI with approximately $2.4 million over three years and delivered through Queensland Department of Primary Industries and AgForce. Leading Sheep provides a framework for increasing the adoption of new technologies and practices by Queensland wool producers. The program is delivered via a network of regional groups that represent key stakeholders. Each group prioritises outcomes specific to their region and provides recommendations for activities to achieve these. The project team and project partners, under the guidance of regional coordinators and extension officers, undertake delivery activities including training, workshops, field days, demonstration properties and technical information delivery. To cater for the vast distances between participants, web-based tools and phone conferencing are used as well as traditional delivery methods.

Production and management topics covered in the Leading Sheep program include:

- Feral dog and fox control strategies,
- Genetic selection,
- Natural resource management,

- Integrated parasite management,
- Feedlotting,
- Meat sheep production and marketing,
- Wool marketing,
- Drought strategies,
- Using climatology tools,
- Capacity building, and
- Computer skills training.

To date predation and drought management have been the main focus of the groups.

There are currently four Leading Sheep regional groups:

- Central West around Longreach (Mitchell Grass),
- South West around Charleville (Mulga),
- Southern Inland around St George (Box/Sandelwood) and
- South East around Inglewood (Brigalow/Trapock)

It is anticipated that up to 150 producers in each of these regions will become involved in the Leading Sheep program during its three year lifespan. In terms of program evaluation, a survey will be conducted six months prior to the completion of the program in 2007. However, there is some anecdotal evidence that more organized baiting programs that have been implemented as a result of the Leading Sheep program are positively impacting on lamb survival rate.

Joint Funded Extension Programs

Several extension programs are funded by multiple Research and Development organizations. This section provides details on such programs.

Bestprac

Bestprac is a Rangelands extension initiative funded by AWI and MLA. The Rural Directions private consulting group is the national coordinator of the Bestprac program and facilitators for Bestprac groups in South Australia. Western Australian Groups are facilitated by Rosemary Bartle, an independent consultant, and groups in New South Wales are facilitated by a number of private agricultural consultants and the NSW DPI. Bestprac has been funded in three phases; in phase 1 $3.2 million was invested in program development and launch; in phase 2 $1.3 million was invested in the delivery of the program over three years, and in phase 3 it is envisaged that groups will evolve into self-directed participatory research groups with access to PIRD funding. Bestprac participants are charged $400 per annum, these fees are subsidized with FarmBis funding in South Australia and Western Australia and with DPI core project funds in New South Wales and Queensland.

Bestprac was launched in Queensland in 1998 and expanded into a national program in 2002. By 2004/05 31 Bestprac groups had been established across Australia with 300 participants representing around 11 percent of rangeland wool producers. In 2005/06 26 Bestprac groups continued to operate with approximately 180 participating businesses. Bestprac groups tend to self select and coordinators rely on word of mouth and advocates from existing groups to engage new participants. New participants either join an existing group or form a new group. Each group has a minimum of five participating businesses and tends to operate within existing, established social groups.

The goal of Bestprac is to improve the profitability of participating rangelands sheep producers along with their wellbeing and environmental conditions by 5%. The aim of the program is to develop a confident and capable network of pastoralists and facilitators who are empowered to solve their own management problems through the exchange of ideas, improvements and technologies by identifying constraints and then benchmarking their performance against local best practices in rangeland management.

Bestprac is delivered in a facilitated peer group environment, employing adult learning principles and participative action research methods. Groups meet four times per year and engage in self-directed learning processes. Bestprac focuses on skill building in

areas of interest to participants that will directly help them to improve productivity and profitability. All Bestprac groups are supported by a facilitator to ensure the effective operation and networking of the group. The ethos behind this program design is that it will enable participants to implement plans immediately. Bestprac groups follow a six step continuous improvement and innovation process devised by Richard Clark from Rural Extension Centre, Queensland:

1. Analyse your situation - Benchmarking
2. Identify your potential impact
3. Design your action
4. Implement your action
5. Assessing your performance – re-benchmarking
6. Creating and synthesizing ideas for further impact

In short, at the start of each year, participating businesses benchmark themselves against best practice. The group uses benchmarking data to determine priority areas to be addressed. Facilitators work with the group to devise a program of activities that will address priority issues. Activities include workshops, seminars, field days, study tours and field trials. The impact of these activities is assessed at the end of each year through business benchmarking. Participants use within-group benchmarking for on-farm profit, wool cut per DSE, return on capital, debt-to-income ratio, wool price per kilo and operating costs, repairs and maintenance and labour as percentages of income to measure farm performance.

As the Bestprac program employs self-directed learning, the content of each program and activities is determined by the group. The majority of Bestprac groups have expressed some interest in improving sheep reproduction efficiency. For example 'Wean more Lambs' trials have been undertaken by Bestprac groups to compare best practice reproduction management with traditional district practices. Workshops and field days on ram and ewe condition scoring and nutrition for reproduction have also been delivered to Bestprac groups that have prioritized reproduction efficiency.

In terms of program evaluation, individual participating businesses give feedback on practice changes as a result of the program through the annual benchmarking process.

A mid-program evaluation was undertaken in 2005 that included structured interviews with 61 participants, case studies of two businesses and one Bestprac group and structured interviews with 11 producers not involved in Bestprac. The evaluation reported that:

- 34 percent of respondents had changed management practices as a result of Bestprac,
- 36 percent of these respondents indicated that the changes they had made as a result of Bestprac resulted in increased profitability,
- 13 percent of respondents had diversified their business,
- 12 percent had improved selling and marketing skills,
- 8 percent had improved overall business management practices,
- 11 percent reported an increase in confidence,
- 8 percent had reduced cost of production,
- 14 percent of respondents indicated that they had made no changes as a result of Bestprac, and
- 25 percent of respondents believed that they had increased productivity but could not see a corresponding increase in profitability.

According to the mid-program review, participation in the Bestprac program has effected practice change in around 4 percent of Rangeland sheep producers, however specific practice changes relating to the management of reproduction cannot be determined from this assessment. Further information may come to light through a full assessment of the impact of Bestprac planned for the end of 2006.

Table 15 below outlines the number of Bestprac groups in each of the AAGIS Regions.

Bestprac	
AAGIS Region	Number of Groups
Western New South Wales	8
Western and South West Channel Country	8
Northern Pastoral	7
Kalgoorlie and Central Pastoral	2

Table 15 – Geographical Location of Bestprac Groups

Best Wool – Best Lamb

The Best Wool – Best Lamb program is funded by the Victorian Department of Primary Industry, AWI Ltd, MLA and the GRDC. The Victorian Farmer's Federation provides support for the delivery of the program. This program has received approximately $2.9 million in funding.

Best Wool was initially launched as Wool 2010 in 1998. At its peak there were approximately 70 groups involving 1700 participants, representing approximately 13 percent of all sheep producers in Victoria. Initially participation in Best Wool – Best Lamb was free of charge, however, an annual membership fee of $385 for established groups and $110 for new groups was introduced in July 2005 coinciding with a drop in participation. Currently there are 34 Groups involving approximately 400 participants remaining on the program representing around 3 percent of Victorian sheep producers.

The Best Wool – Best Lamb program is delivered through producer groups using self-directed peer learning processes. Individual groups select a coordinator to organize the learning activities, communicate new research and development information, challenge producers to trial new technologies and review and report the progress of their groups. Group members identify key issues and the best learning approaches to assist them to reach their individual business goals. Other extension approaches are used to complement group activities including, regional information forums with expert speakers, telephone seminars and partnerships with specific research and development projects. The groups have yearly planning sessions to agree on the topics that are to be addressed, topics include:

- Pastures
- Grazing management
- Weaner management
- Sheep bloodlines
- Sheep productivity
- Benchmarking
- Business management

- Cost of production
- Marketing and risk management

Although sheep reproduction efficiency is covered in the Best Wool – Best Lamb program, groups have not typically focused on this area as a critical issue. The relatively low levels of interest in this area is highlighted by the fact that Lifetime Wool participation was offered to all of the groups, but only three groups took up the offer.

In terms of program evaluation, impact assessments were conducted bi-annually throughout the life of the program. According to a review conducted in 2002 (Coutts, 2002) 55 percent of participants made a significant change to management practices as a result of participating in Best Wool - Best Lamb. While the changes cited covered a wide range of enterprise issues, changes in time of lambing was cited by some. In the final program evaluation conducted at the end of 2005, (Coutts, 2005), 48 percent of a sample of 30 participants indicated that they had made on-farm changes as a result of participation in the program to improve productivity. Changes in flock composition were a frequently cited change.

In terms of driving practice change, the Best Wool – Best Lamb program appears to have been one of the more successful, although its effectiveness seems to have declined since the introduction of charges. It is estimated that it has driven practice change in approximately 6 percent of its target audience, Victorian sheep producers, albeit that changes in reproduction practice resulting from the program are likely to have been negligible in light of this representing a small component of the program.

Table 16 below demonstrates the AAGIS Regions where Best Wool – Best Lamb Groups are currently operating.

Best Wool – Best Lamb AAGIS Region	Number of Groups
Mallee and Wimmera	8
Gippsland and Western Districts	14
Central North	6
University Groups	5

Table 16 – Geographical Location of Best Wool – Best Lamb Groups

SheepPlus (Formerly Look@Wool)

The SheepPlus program is funded by AWI and Primary Industries, South Australia. This program targets South Australian sheep producers that are considered to operate just below the lead performers in the industry. SheepPlus is delivered as a group, facilitated learning experience with workshops and training provided as required by the group. The group learning process used in this program, developed by the Queensland Department of Primary Industries, enables groups to identify issues that they wish to address. A facilitator supports the group in this process and then assists them with identifying training activities that need to be undertaken and on-farm changes that need to be made to address the identified issues.

Participants are charged $100 for the first year of the program and $200 for the second year. There are currently seven SheepPlus groups with a total of 61 participants, representing approximately 1 percent of the sheep industry in South Australia.

In terms of content relating to sheep reproduction efficiency, there is no evidence of specific training and support in this area, however, there has been some interest by most groups in the Wean More Lambs program as well as Lifetime Wool.

In terms of program evaluation, interviews are undertaken to determine precisely the practices that have been adopted by SheepPlus participants. Evaluation interviews have identified that the main practice changes adopted relating to sheep reproduction were changes in time of lambing and the adoption of a more objective approach to measuring reproduction performance.

Table 17 below demonstrates the AAGIS Regions where SheepPlus Groups are currently operating.

Sheep Plus AAGIS Region	Number of Groups
South East	5
Mid North and Murraylands	1
York Peninsula	1

Table 17 – SheepPlus Groups

8X5 Wool Profit Program

8X5 Wool Profit Program is an integrated research, development and extension program designed to assist Tasmanian woolgrowers to lift overall profitability. The program objective is to help participants achieve an eight percent return on assets over a five year period. The 8 X 5 program is funded and delivered by AWI Ltd, the Tasmanian Institute of Agricultural Research, Tasmanian Department of Primary Industries, Water and Environment and the University of Tasmania. The program makes use of monitor farms to demonstrate the implementation of on-farm 'best-practice' in an attempt to merge research and science with 'face-to-face' communication between farmers and researchers to ensure a greater understanding of the challenges faced by both parties in the on-farm situation. The aim of the program is the effective communication of new industry and technical developments to woolgrowers.

The 8 X 5 program content is a series of projects covering benchmarking, best practice information and producer group improvement initiatives. There are no specific details available regarding content relating to sheep reproduction efficiency, participation or adoption effectiveness. Therefore further analysis of this program regarding its effectiveness in effecting change in sheep reproduction efficiency has not been possible.

Lifetime Wool

This research and extension program was initiated in Western Australia and Victoria in 2001 and is currently being rolled out across South Australia, New South Wales and

Tasmania. Lifetime Wool has demonstrated that the more precise feeding of ewes to achieve condition score targets at joining and throughout pregnancy can increase farm profit by an estimated $2.00 to $5.00 per ewe. Indeed, according to findings to date, 30 to 60 percent of this profit can be attributed to the ewe's progeny producing more and especially finer wool over their lifetime. The program is designed to deliver profitable ewe management guidelines to woolgrowers across Australia.

Lifetime Wool is primarily funded by AWI, the Department of Agriculture and Food, Western Australia and is supported by the Departments of Primary Industry in Victoria, New South Wales and Tasmania and the South Australian Research and Development Institute. The total budget over eight years is $9.4 million for the research and development project, economic analysis, systems modeling, extension and evaluation. Approximately $1.0 to $1.5 million has been allocated to extension. To date, 130 producers have been involved in the program, of which 80 are Victorian.

By measuring the wool quality and quantity produced by ewes and their progeny over their lifetime, the Lifetime Wool Project is refining condition score targets during the reproductive cycle to optimize ewe and progeny per head and per hectare. A number of 'key messages' have been developed from the Lifetime Wool research program which enable woolgrowers to determine their optimal feeding solution during pregnancy and lactation to increase profits. The 'key messages' are as follows:

- Whole farm profit is sensitive to the changes in condition of ewes during each year,
- Production from ewes and their progeny can be predicted from knowledge of the ewe condition score profile,
- Condition score is a quick and reliable tool for managing ewes to target,
- Condition score can be managed to achieve predictable ewe fleece weight, fibre diameter and staple strength,
- Ewes higher in condition score at joining conceive more lambs,
- Lamb survival at 48 hours can be predicted from changes in condition score between joining and lambing, albeit that the response is modified by environmental conditions at lambing,

- Improved ewe condition during pregnancy increases the progeny fleece weight by up to 0.2 kilograms and decreased fibre diameter by up to 0.4 microns,
- These effects are permanent for the lifetime of the progeny and are independent of birth type and sire source,
- Managing twin bearing ewes better will increase production, and
- Ewes with higher condition score at lambing will have less mortality than ewes with lower condition score.

During 2001-2003 plot scale research was conducted on two significant grazing enterprises (+4,000 ewes) in Hamilton (Victoria) and Mt Barker (Western Australia). The research was aimed at developing response curves between nutrition and ewe and progeny performance, demonstrating impact on ewe mortality, reproduction efficiency and wool production and lamb survival and lifetime wool production. From 2004 to 2007, paddock scale research is being conducted on 15 sites across Western Australia, Victoria, New south Wales, Tasmania and South Australia to validate and test robustness based on two nutrition programs identified from the plot scale research.
From 2005, 150 demonstration farms are being established across the Southern Agricultural Zone to test the practicality of the guidelines and specific condition score targets in different localities.

From 2006 to 2008 a two-year accredited training course is to be offered in Victoria in conjunction with RIST. The cost to participants is $720 for two years. The target is 50 groups of four producers and 25 groups are scheduled to commence in Spring 2006. The groups will be run by DPI staff and private consultants. Participants in this course have typically been involved in other extension programs. The focus of the course is on the individual participant's farm. Additional Lifetime Wool content will be introduced to other extension programs and training will be provided to DPI staff and private consultants.

Each demonstration farm is a two-year program which holds six sessions per annum with group sizes capped at 4 participants. Each workshop is facilitated by a leading industry expert. Year 1 of the Lifetime Wool program covers:

- Keeping records for a primary production business

- Developing a livestock feeding plan
- Implementing feeding plans for livestock

Year 2 covers:

- Analysing and interpreting production data
- Developing livestock health and welfare strategies

Mid program evaluations have reported that, on average, participants thus far have increased weaning percentages by 10 percent in both years, compared to their long-term average and reduced ewe mortality to less than 2 percent. However, this project is too immature to fully examine adoption impact.

Table 18 below demonstrates the AAGIS Regions where Lifetime Wool plot scale and paddock scale research projects are operating and where demonstration farms are either existing or being established.

AAGIS Region	LifeTime Wool Plot Scale Research Number of Projects	LifeTime Wool Paddock Scale Research Number of Projects	LifeTime Wool Demonstration Farms Number of Farms
New South Wales Tablelands		1	10
Riverina			2
South East		1	10
South West	1	1	1
Central and Southern Wheatbelt		4	14
Gippsland and Western Districts	1	4	42
Wimmera			6
Central Northern			10
Central West		1	
Northwest Slopes and Plains		1	
Northern Tasmania, Huon and Midlands		1	

Table 18 – Geographical Location of Lifetime Wool Projects

Extension Programs Funded by State Departments of Primary Industry

State Departments of Agriculture play a support or facilitation role in most of the industry funded extension programs discussed in previous extension. In addition to this role, most State departments with responsibility for agriculture raise awareness for best practice through simple publications and some seminars. This section describes such publications that contain content relevant to best practice reproduction management however further analysis of the impact of such publications on sheep reproduction efficiency is not possible as the State Departments do not track the distribution of these publications or evaluate their impact.

Prime Notes - Department of Primary Industries and Fisheries, QLD

The Department of Primary Industries and Fisheries, Queensland publish and distribute Prime Notes in the sheep breeding area, the majority of which were developed out of the Lamb Boost program. Prime Notes are available on-line or on CD-ROM free of charge. A full list of the 22 Prime Notes relating to sheep breeding is provided in appendix X.

Agriculture Notes – Department of Primary Industry, VIC

The Victorian Department of Primary Industries produces an information notes series called 'Agriculture Notes'. Three Agricultural Notes relating to reproduction efficiency are listed in appendix X. The Victorian Department of Primary Industries also produces a newsletter for producers, *Marksman News: Targeted Lamb Production*, three times a year. This newsletter covers issues relating to prime lamb production including reproduction and survival issues.

Agfact - Department of Primary Industry, NSW

The Department of Primary Industry, New South Wales produces an information note series called Agfact. Two Agfact publications relevant to reproduction efficiency are listed in appendix X.

FarmNotes - Department of Agriculture and Food, Western Australia

FarmNotes are short, issue focused, technical reports produced by the Department of Agriculture and Food, Western Australia (DAFWA) and targeted at primary producers. FarmNotes are the main printed communication produced by DAFWA to communicate research findings to producers and agricultural industry stakeholders. Eight FarmNotes that are relevant to reproduction efficiency are listed in appendix X. In addition to

FarmNotes, DAFWA also produces and distributes Ovine Observer for the Western Australian sheep industry, as well as AgMemos which are agricultural region specific newsletters. Sheep Updates are an annual conference series run across Western Australia by DAFWA. In 2005 there was a focus on sheep reproduction with a session dedicated to the delivery of three papers on the economics of managing for improved reproduction efficiency.

Observations

For the following reasons, it is unlikely that extension programs have had a significant impact on the reproduction management practices of the industry:

- Reproduction forms a small component of content in extension programs with prescribed content and is not a major or common focus of extension programs that uses a self-directed learning process.

- Extension programs have achieved limited penetration into and effective adoption from their target audiences (as assessed by independent evaluations)

- While there has most certainly been extension activities in regions that have achieved improved average marking rate, there have also been extension activities in areas that have not improved average marking and average marking rate has improved in regions where they has not been a lot of extension activity. The relationship between improved marking rate is stronger with favourable agronomic and climatic conditions and distribution of favourable genetics than it is extension programs.

Felt Need for Improved Reproductive Performance

There is little evidence that supports the notion that best practice reproduction methods have been broadly adopted by the Australian sheep industry. While, surveys investigating producer intended or actual practice change suggest adoption of some practices might be as high as 50 percent of producers, such proposed levels of adoption are not reflected in improved marking rates. National marking rate data suggests that improvement has only occurred in regions where there are climatic and agronomic conditions more suitable to reproduction effectiveness and/or where there are a higher portion of cross-bred ewes and importantly, that improvement has been minimal.

Indicators of Absence of Felt-Need

The very nature of the Australian sheep industry is the single most restrictive factor with respect to broad adoption of best practice sheep reproduction methods. While the emerging sheep meat sector is growing rapidly, the Australian sheep industry is still primarily focused on wool production, where optimal reproduction efficiency is not considered a priority. Furthermore, the high proportion of pure merino ewes in the Australian flock that is a product of a wool focused industry restricts the reproductive capacity of the Australian industry by virtues of the merino breed's relatively poor maternal traits.

However, there are other more subtle characteristics of the Australian sheep industry that render optimal sheep reproduction management practice non-compelling for most Australian sheep producers and these are best demonstrated by comparing the Australian sheep industry with its New Zealand counterpart. The average reproduction efficiency rate of the Australian sheep industry for the past 15 years, as measured by marking rate, is approximately 77 percent.[10] In comparison, the average marking rate for the New Zealand flock has increased from 100 percent to 130 percent over the same

[10] ABARE Farm Survey Data

period.[11] There are a number of factors which make the adoption of best practice reproduction techniques a considerably more compelling proposition for New Zealand sheep producers than their Australian counterparts:

- The Australian flock is comprised mostly of Merino ewes, which have poor maternal characteristics than the non-merino ewes that comprise the New Zealand flock. This means that results from implementing best practice are typically greater in the New Zealand production environment. This partially explains why improvements in reproduction in the Australian industry have occurred mostly in areas where there is a greater distribution of cross-bred and non-merino ewes and in the prime lamb sector.
- The Australian production environment is characteristed by variable and relatively unpredictable rainfall patterns, whereas New Zealand production areas have relatively predictable medium to high rainfall. This means that it is easier and less risky to implement nutrition strategies that favour reproduction effectiveness in New Zealand. This partially explains why improvements in reproduction the Australian industry seem to have been largely confined to the medium-to-high rainfall areas of south east Australia.
- Australian sheep farms are typically large broad-acre properties running low stocking rates, whereas New Zealand properties are much smaller and tend to operate much higher stocking rates. This means that the more intensive management of stock that is required to achieve optimal reproduction performance is easier in the New Zealand production environment. This partially explains why improvements in reproduction in the Australian industry have occurred in areas that on average, are characterized by smaller land holdings.
- The financial incentive to adopt best practice reproduction methods is significantly greater for New Zealand producers. Many New Zealand farms are characterized by high levels of debt, whereas Australian farms typically have significant levels of equity. Furthermore, there has been a reduction in farm subsidies in New Zealand from an effective level of agricultural assistance of approximately 50 percent in the

[11] Bray, A. (2005), 'Kiwis Can Fly – 30% Higher Lambing Rates in 15 Years', *Proceedings of Sheep Updates 2005*

early 1980s to less than three percent in the early 1990s[12]. Collectively, these issues have placed more pressure on New Zealand producers to obtain improvements to the financial performance of their business.

By virtue of these differences, adoption of best practice sheep reproduction techniques has been significantly greater in the New Zealand industry. For example:

- Genes have been introduced to the New Zealand flock from high fecundity breeds such as East Fresian and South African Meat Merinos
- There is a high proportion of cross-bred ewes in the New Zealand flock
- There is a wide industry focus on using quantitative genetics in sire selection decisions (Sheep Improvement Limited) in New Zealand
- The New Zealand industry has experience improved animal health, facilitated mostly through the adoption of vaccines against abortive diseases
- The number of hoggets joined has increased to approximately 30 percent of the New Zealand flock
- Increases in pasture growth, fertilizer consumption, carcase weight and twinning and triplet rates collectively indicate better nutrition management among New Zealand sheep producers
- Pregnancy scanning has increased to an estimated 60 percent of the New Zealand flock
- New Zealand producers only lamb in spring

Additionally, the economics of optimal reproduction efficiency in the Australian sheep industry is unclear. Economic analysis of the LambMax program that promoted best practice reproduction found that many of the promoted practices were not economically viable within common operating structures. Additionally, independent work demonstrates

[12] Walker, A. (1993), 'New Zealand as a Case Study for Understanding Agricultural Economics and the Process of Restructuring in the Agricultural Sector', MAF Policy

that there is limited correlation ($0.02 < r^2 > 0.3$) between higher weaning rates and gross margin per hectare in most typical Australian sheep enterprises.[13]

Interview Sample Results

In order to identify the felt need for reproduction best practice methods and technologies the consultants have conducted 18 interviews with a range of sheep producers across Southern Australia. It was originally intended that a total of 40 interviews would be conducted across Southern Australia. However, in the original scope a large portion of these interviews were to be participants in a number of AWI extension programs. AWI's decision not to provide access to these participants has resulted in a smaller than intended interview sample.

Sample Background

This sample presents information on which only preliminary assessment can be made because it is too small to be representative and the review has experienced difficulties in sourcing an adequate number of producers that would not be considered 'progressive farmers'. The preliminary sample has the following characteristics:

- It is comprised of ten mixed cereal and sheep operations, four mixed livestock operations and three sheep only operation.
- Property sizes range from 250 hectares to 27,000 hectares
- 12 of the respondents had no post secondary school qualifications and six had diploma or undergraduate qualifications
- Seven respondents considered wool to be their key enterprise, three considered cropping to the be their key enterprise, four weighted all of their enterprises as being equally important and four considered another enterprise (cattle or sheep stud) to be their key enterprise

[13] Holmes and Sackett Internal Data

Key Management and Risk Issues

The respondents were asked what their key management and risk issues were. Climate conditions and patterns were by far the most important with eleven of the respondents stating this as their primary concern. The next most important issue was commodity prices with five respondents rating this issue as a primary concern. Shrinking margins, labour shortages, pasture management, debt levels, lamb survival and pest control were all mentioned by at least 3 respondents and natural resource management and production costs were mentioned by 2 respondents.

Interestingly, all respondents explained that they take a whole-of-farm approach to making management decisions and assessing risk.

Major Source of Internal and External Information for Decision Making

All respondents relied on some form of internal information (farm data) to make decisions. The most common source of external information was weather and commodity reports, and mass media (internet, radio, press), with eight respondents mentioning weather and commodity reports and seven respondents mentioning mass media reports. Six respondents mentioned they sought information from a consultant, five from DPI and extension literature and three from formal workshops.

Major Non-Operational Issues

Succession planning was the major non-operational issue for the sample, with nine respondents mentioning that it was a current issue for them. Time was the other main non-operational issue, with seven respondents stating its importance.

Measuring Enterprise Performance

A range of methods for measuring enterprise performance were identified by the sample. Cost of Production and Profit per hectare were the most frequently measured variables, mentioned by nine and ten of the respondents respectively. Enterprise profitability and cashflow were also mentioned but by about half as many respondents. Cashflow was

generally assessed by the amount of cash in the bank account at the end of the year and an intuitive sense of cash coming in and going out.

Extension Program and Field Day Participation

Five of the respondents had not attended an extension program in the past five years and three had never attended an extension program. Eight respondents had attended extension programs in the past five years. Twelve of the respondents attended field days relatively recently and six of the respondents didn't attend field days.

Other Source of Knowledge and Advice

Eleven of the respondents used a whole of farm consultant and seven did not. Eleven of the respondents consulted with stock, seed and fertilizer agents on a regular basis, and five with an agronomist. Other sources included other producers, clients and the DPI.

Sample Reproduction Practices

The average marking rates for the enterprises interviewed ranged from 75 percent to 168 percent. Nine of the respondents believed that their reproduction performance was better than the district average, six believed it was average, one thought it was worse and two did not compare with other operators in their district. Nine respondents believed that they were operating at their maximum lambing rate either because it was at the biological limit, or because it would involve adjusting other enterprise variables such as stocking rates. Five believed they had room to improve.

Eleven of the respondents lambed in spring and six lambed in autumn.

Six respondents believed improving marking rate was a very important issue, a further five believed that it was either important or becoming important and three believed it was not an important issue. The balance did not operate sheep enterprises. Respondents

that thought it was a very important, important or emerging important issue believed so for one or more of three reasons:

- To replace wethers that were being sold into the live export market
- To sell lambs into sheep meat markets
- To increase the number of stock from which selection can be based to improve the genetic quality of the flock.

The most common practice used to increase reproduction rate was the culling of dry ewes and poor mothers, with twelve respondents engaging in this practice. Nine respondents used what they believed to be an optimal ram percentage and eight respondents used sheltered paddocks for lambing. Most that used sheltered paddocks, did so because they had paddocks with natural shelter.

Twelve of the respondents actively sought to have their ewes in good condition at joining with five setting formal targets and measuring and eight visually assessing ewe condition. Those that did not set formal targets and measure suggested that the practice was impractical and would not provide any significant improvement.

Less frequently used practices were pregnancy scanning (five respondents), predator control (four respondents), vaccination against abortive disease (four respondents), separation of twins and singles (three respondents), rejoining (one respondent) and teasers (two respondents).

Those that used pregnancy scanning did so to either assist with culling decisions or to separate single and twinning ewes. Those that did not use pregnancy scanning did not believe it was economic because either they:

- Believed their flock was adequately fertile,
- Did not separate single and twinning ewes as a practice, or
- Believed it was not an economic practice.

The most common predator problem was foxes and wedgetail eagles. Foxes were baited, usually as part of a program with neighbours. Wedgetails were mostly viewed as a problem that was not resolvable, but at the same time, not significant.

Those that did not separate twins and singles did not do so either because they did not have adequate paddocks to implement the practice or did not consider the extra effort and cost of scanning worthwhile.

Vaccination was part of a six-in-one vaccination, with no one vaccinating against specific abortive diseases and teasers were only used in conjunction with AI programs.

The main reasons cited for not adopting reproduction practices were related to the economics of the practice (thirteen respondents) or the lack of practicality of the practice (nine respondents). Interestingly, thirteen of the respondents said they had been using their current reproduction management practices for more than five years and only three had adopted new practices in the past five years.

Only one respondent had participated in a collaborative R&D project relating to sheep reproduction. Most of the respondents (eight) were not aware of any R&D being undertaken in the area of sheep reproduction, six respondents believed that the R&D that has been undertaken and is currently being undertaken is not useful and three respondents thought R&D programs in the area were useful. In terms of accessing information about best practice sheep reproduction management, most producers thought it was easy to access the information if they wanted it.

Discussion

The analysis of the interview results with this small sample questions the nature of innovation in sheep reproduction management. While there has certainly been some innovation (such as the use of pregnancy scanning and separation of twinning and single ewes), they only seem to demonstrate relative advantage with some production systems and some production goals. Most of the other practices (predator control, sheltered lambing paddocks, culling of dry ewes and poor mothers and having ewes in good condition for joining) have either been in existence for a substantial period of time or any innovation presents only incremental improvement in precision (i.e. setting and measuring condition score targets).

Without a more representative interview sample it is not possible to predict how extensively these practices are adopted in the sheep industry and why they have or haven't been adopted. However, this analysis does clearly demonstrate that producers

will only adopt reproduction practices that are compelling within the context of their specific production goals and business model and climatic and agronomic conditions.

Recommendations

Driving widespread industry adoption of best practice reproduction management will not be an easy task. The proposition of increasing input costs, labour and management inputs and potentially enterprise risk for the sake of producing more lambs is not compelling to a large portion of the industry. This is evident in the relatively stable average marking rate for the industry over the past 15 years.

The rationale that all sheep enterprises should be investing in producing more lambs simply because the market conditions for lamb meat are favourable is flawed. Particularly in the case of pure merino flocks, the economic case for investing in best practice reproduction management is at best marginal.[14] In prime lamb and seedstock flocks, enterprise performance is more likely, within boundaries, to respond positively to additional investment in best practice reproduction management, but this is by no means a universal rule. This is evident in the apparent improvement in marking rate over the past 15 years among prime lamb producers in certain regions of the south east of Australia and the fact that there are individual prime lamb and terminal sire seedstock producers who routinely achieve marking rates in excess of 100 percent.

Despite the challenges associated with driving industry-wide improvement in reproduction efficiency, a strategic industry issue commands that the industry prepares itself for the possibility of a shift in the current operating environment. There is considerable evidence that consumer markets are becoming increasingly linked to primary production assets through traceability regulations and general environmental awareness among consumers. If clear evidence emerges that low marking rates in the Australian industry are the result of post-natal fatalities, there is a risk that Australian sheep products will be boycotted by consumers and market regulators on the grounds of animal welfare. Such an eventuality has the potential to be catastrophic for the wool and meat sectors. However, it is important to note that this does not at all negate from the fact that reproduction management practices will need to be compelling for producers to adopt them, albeit that a market boycott will change perceptions of what is compelling. This is discussed further in the next subsection.

[14] Holmes and Sackett (2007) – Need to confirm with David's final report

Commercial versus Strategic Rationale

It is important to clearly note that the case for driving adoption of best practice sheep reproduction management needs to be rationalized at two levels. However, irrespective of the two rationales, the process that will drive adoption is the same.

The first rationale is the case for improved enterprise economic performance in the current operating environment. While there is no doubt that improved reproductive performance would increase the profitability of some enterprises, this seems far from a universal rule. The resulting increased stocking rate, demand on feed resources and increased management and labour inputs need to be taken into account when considering both the economic impact of improved reproduction performance and the enterprise risk profile that is acceptable to the enterprise business model. This will vary across enterprise type, agronomic and climatic conditions and enterprise business model. It is likely that, within limits, improved reproduction effectiveness is going to be more important to prime lamb producers, seedstock producers and mixed sheep enterprises that have a sheep meat market focus. These limits will be defined by agronomic conditions, risk profile and other whole-of-enterprise goals. However, in the case of merino producers, the argument seems far from convincing. Unless there is a compelling case for an enterprise to adopt practices that improve reproductive effectiveness, adoption will not occur. As such, for broad industry improvement to occur, packages that are tailored for specific enterprise profiles are necessary.

The second rationale for driving adoption of improved reproduction management is a strategic one that resides in the animal welfare argument. It is argued by some that as consumer markets become more closely linked to primary production assets that high rates of lamb and weaner death will increase the risk of boycotts of Australian sheep products. It is easy to see this rationale as justification for a blanket approach to the promotion of reproduction management practices (i.e. the industry must adopt best practice in order to have a license to operate in the future). This has not worked in the past in the case of many livestock innovations and will not work in the case of reproduction management. The reason for this is that he basic compelling proposition rationale remains. If solutions are not compelling to target enterprises those enterprises

will not adopt just to satisfy specific markets and their requirements. This is currently being demonstrated in the case of muelsing practices. The boycott of Australian wool products by the United States based retailer, Abercrombie and Fitch, has certainly accelerated investment in alternative muelsing innovation by various innovation agencies, but there is no evidence of widespread producer investment in muelsing alternatives or adoption of those alternatives. The reason for this is that those alternatives are not perceived as compelling propositions.

Most certainly, the threat of a boycott by major markets will alter the nature of practice packages that are considered compelling, but such an event will not make existing practice packages necessary compelling per se. It is likely that practice packages that involve significant increases in input costs, labour and management effort and enterprise risk will equally motivate producers to leave the sheep industry and use production assets for other means as it will motivate them to adopt practices that are conceived as non-compelling.

As such, whatever the rational for driving adoption of best practice reproduction management is, the end result must be the identification of solutions that are compelling to target producer segments.

Foundation for Compelling Cases

It would seem from the analysis in this report, that there are two factors that are consistent with improved reproduction performance:

- Agronomic and climatic conditions that are favourable to improved reproduction performance; and
- Flock genetics that favour improved reproduction performance.

Agronomic and climatic conditions are largely set by the geographical location of the enterprise. While the genetic base is determined to a significant degree by the nature of the enterprise production goals, some selection can be made to improve the reproduction performance of the flock, albeit that in some cases this may result in a

trade-off between product performance and reproductive performance, particularly in the case of wool enterprises.

Achieving the optimum trade-off between maternal and product performance genetics would seem critical in developing the basis of a compelling case for improved reproduction management packages for most enterprises. Nutrition and husbandry practices designed to improve reproduction all involve increased inputs in the form of supplementary feed, professional services, labour and management time and in some instances capital investment. In many instances they also involve changing the risk profile of the enterprise and/or have adverse impacts on other aspects of the whole of farm operation. These nutrition and husbandry practices mostly result in only an incremental improvement in reproduction performance.

Depending on the degree of selection, selecting superior maternal genetics involves relatively little inputs in terms of costs and labour and management time. Importantly, if the right genetics for the specific enterprise are selected it has the potential to provide disproportionately greater benefit for the inputs required to achieve that benefit. This in turn, potentially provides a platform to leverage benefit from other relatively input intensive husbandry and nutrition practices.

Tailored – Targeted-Compelling Packages

In order to optimize the likelihood that producers for whom a best-practice reproduction management package is compelling adopt that package and that the industry is in a position to effectively respond to a change in market conditions with respect to animal welfare awareness, the reproduction management needs of different homogenous segments of sheep producers must be understood and packages tailored that have the best chance of representing a compelling case with respect to those needs.

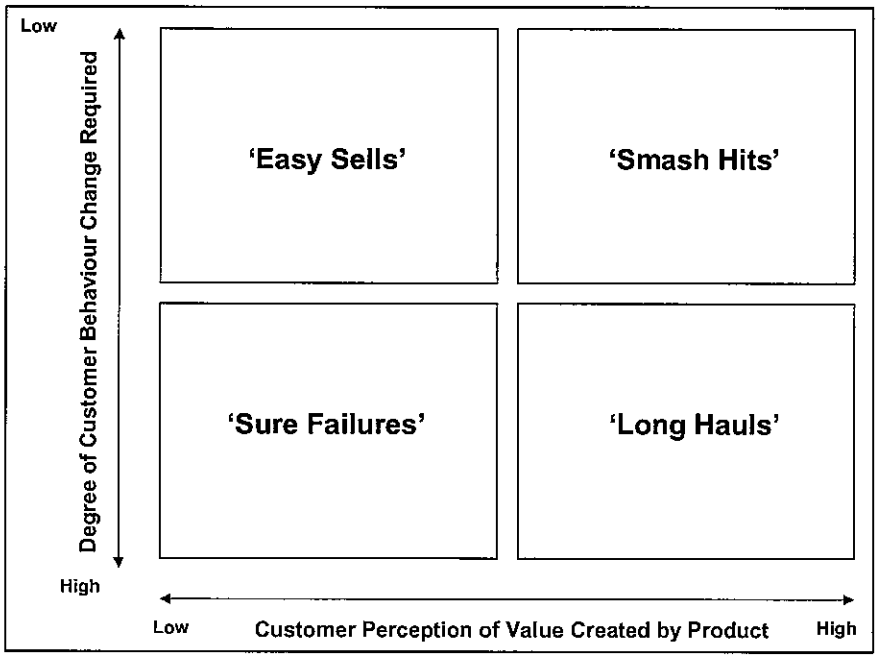
As with all innovations, new reproduction management packages must be address the following if they are to be adopted by the targeted adopter:

- *Relative Advantage* refers to the degree to which a product or service based on the innovation is perceived to be superior to the solution that it supersedes. A number of

attributes of the innovation may affect its Relative Advantage including the initial cost of the innovation, the degree to which it contributes to a reduction in operating costs or increased revenues, the degree to which it makes a task easier to perform or the degree to which it confers a superior status in the industry. Additionally, the immediacy at which the relative advantage is realised also impacts on the rate of adoption. For example, pregnancy scanning is only likely to be compelling to producers who believe they are overstocked and are trying to improve the reproductive capacity of their flock and as such will benefit from accelerating the culling of dry-ewes, or to producers who are actively separating twins and singles.

- *Compatibility* refers to the degree to which an innovation is perceived as consistent with the existing values, past experiences and felt-needs of potential adopters. Obviously, the more compatible an innovation with the existing values, past experiences and felt-needs of potential adopter segments, the more likely it is to be adopted by individual adopter segments. An innovation can be compatible or incompatible with socio-cultural values and beliefs at a societal or industry level. Because previous experiences are one of the main mental tools that individuals use to evaluate an innovation, innovations that are similar to previously adopted innovations (particularly if adoption involves limited change in practices), are likely to be adopted more readily. However, this can also cause over-adoption. The most important aspect of compatibility is the degree to which the product based on the innovation is compatible with the felt-need of the potential adopter. This is a critical input to whole of product design. For example, the practice of separating twins and singles is only likely to be compatible with an enterprise that has adequate paddocks to perform this practice. However, even if it is compatible, the extra labour required may decrease the relative advantage of this practice.
- *Trialability* is the degree to which an innovation may be experimented with on a limited basis prior to a full adoption decision being made and implemented. Generally speaking, innovations that exhibit a high degree of trialability experience higher rates of adoption. Again, this is not as a critical factor in the rate of adoption, because in most cases it can be engineered into the whole product design.
- *Observability* is the degree to which the results of an innovation are visible to others. Innovations that are easily observed and communicated to others tend to exhibit higher rates of adoption.

Most of the variance in the rate of adoption of innovation (49 to 87 percent) is explained by these above five attributes of the innovation.[15] Because, complexity and trialability can typically be addressed through product design, it is relative advantage and compatability with felt-needs that primarily drive adoption. If we translate this into simple sales industry jargon, 'smash hits' in terms of sales usually come from products that offer improved value for the customer, but require limited change in the customers behaviour for the customer to use those products. This is demonstrated in the Figure below[16]. Reproduction management practice packages that can be designed to offer significant benefit with limited change in the producer's existing behaviour are more likely to be widely adopted.



To be compelling they must offer moderate benefit in terms of enterprise performance factors that are important to the producer and require limited change in the producer's current practices and models. If they involve any significant change in the producer's current practices and models, the benefit as perceived by the producer must be significant in terms of order of magnitude.

[15] Rogers, E. (1995). *Diffusion of Innovations*, Free Press, New York.
[16] Gourville, J.T. (2006), 'Eager Sellers, Stoney Buyers: Understanding the Psychology of New Product Adoption', Harvard Business Review, (84)6.

The nature of specific reproduction practices that are compelling either individually or as part of a package is determined by:

- Enterprise business model and production goals
- Enterprise risk profile
- Agronomic and climatic conditions

As such, the industry must be segmented according to these variables and packages designed that have the greatest likelihood of being compelling to producers that form those segments in the current operating environment, or in an environment characterized by an animal welfare conscious consumer.

Proposed Process

Getting the Right Data

The absence of reliable and consistent industry-wide data on the causation of low and consistent average marking rates, makes it difficult to attribute cause and quantify the causes across different regional enterprise sectors. Indeed this will be difficult data to collect. Producers who scan their ewes for pregnancy should be able to provide competent conception data and indeed most producers should be able to provide reasonably reliable visually assessed conception data. However, because of predation and the requirement for continuous observation, reporting on weaner, and particularly lamb losses, is far more difficult. However, this doesn't negate from the need to acquire at least some observational data upon which reasonable triangulation can be based.

It is recommended that questions pertaining to both observational and objectively measured (scanned) conception rates and observational lamb and weaner loss rates be included in the annual ABARE Farm Survey instruments. Furthermore, as part of the significant, industry-wide consultative process to be undertaken (discussed in the next section) indications of lamb and weaner loss rates should be acquired on a regional enterprise sector basis both through producer interviews and by consulting with advisors and other professional service providers that service specific regional enterprise sectors. This is necessary to provide the depth of information that is needed to design product

packages and also as a basis for triangulation against the ABARE Farm Survey data, which in some regional enterprise sectors suffers from low sampling levels.

Profiling Regional Enterprise Sector Needs

Segmentation

The careful and deep profiling of the reproduction management practice needs of relatively homogenous groups of sheep producers is the major recommendation of this report. If we segment the industry according to the regional enterprise sectors discussed in this report, there are a total of 60 segments of relatively homogenous groups of producers to analyse in southern Australia. An analysis of these segments based on primary market research methods would be an extensive and costly exercise. As such, it is recommended, subject to debate, that while the enterprise classifications of prime lamb specialists, sheep specialists and mixed sheep producers should remain as a parameter for segmentation, the geographical segmentation criteria may need to be broadened for the purpose of practical analysis. The boundaries for geographical segmentation are best determined by a sheep industry expert, but a suggested segmentation might use the following segments:

- New South Wales Highlands
- Western New South Wales
- North East Victoria
- North West Victoria
- Southern Victoria and Tasmania
- South East Southern Australia
- Western Australian Wheatbelt
- South West Western Australia
- Southern Western Australia
- Rangelands

Such a geographical segmentation will reduce the number of segments in the analysis by 50 percent, while hopefully maintaining similarity in climatic and agronomic conditions within each segment.

Segment Profiling

Within each geographical segment a sample of prime lamb producers, sheep specialists and mixed sheep enterprise operations needs to be identified. These samples should include producers that have managed a consistent marking rate, managed a marking rate that has improved over the past 10 years and producers who do not manage marking rate at all. The size of the sample should be at least five in each regional enterprise sector, but as large as project resourcing allows.

In-depth interviews with these producers will then be undertaken to determine:

- The sensitivity of their specific business model to reproduction efficiency;
- The nature of reproduction management practices that are currently undertaken, if at all, and why they are undertaken;
- The genetic, husbandry and/or nutritional management practices that can be deployed in the operation to improve reproduction performance and why those practices are currently not undertaken;
- In light of the above, the package of genetic, husbandry and/or nutritional management practices that will be adequately compelling to drive adoption either in the current operating environment or in an environment that is characterized by an animal welfare conscious marketplace.

The outcomes and opinions formed from these interviews should then be triangulated with various livestock experts that have specific sectorial and regional expertise in order to test their validity.

Product Development Protocols

The deep knowledge of segment needs obtained from the process above should provide adequate information on which the development of reproduction management solutions

can be generically tailored for a region and basic enterprise business model. For example, the genetics platform, predation management and nutritional requirements for optimal reproduction management should be relatively generic within a regional enterprise sector. However, issues such as the use of pregnancy scanning and establishment of sheltered lambing paddocks will depend on individual enterprise production goals and property topography.

This process will also identify clear objectives for future R&D in the area of sheep reproduction efficiency and identify areas that should no longer be pursued.

Channel Development

The limitations of traditional extension programs as a channel to producers has been well lamented in the various investigations undertaken on behalf of MLA by this consultant[17]. This does not mean that extension should be ignored as a channel and indeed, every effort should be made to ensure that specific reproduction management packages are promoted through extension programs that target producers for whom those reproduction management packages are likely to form a compelling proposition. Similarly, the knowledge that extension program managers have of their clientele, will be a valuable input into the design of compelling packages. Nevertheless, the fundamentally limited reach of traditional extension programs must be acknowledged and addressed.

It has already been noted by MLA that the livestock consulting industry is potentially a powerful emerging channel, albeit it currently has limited reach. A review of the factors driving this channel and the nature of its market is being conducted under the first year program of the CRC for Innovation in the Australian Sheep Industry. Claims have also been made that the Pregnancy Scanning service sector may be an effective channel to promote best practice sheep reproduction management. Very little is known about this sector in terms its size, its, reach, the nature of its customers and the various business models that comprise it. Without this knowledge, we are unable to determine if it is able to form an effective channel, or critically, how, if at all, we are able to develop

[17] Australian Venture Consultants Pty Ltd (2006) *Hearts and Minds Discussion Paper,* Meat and Livestock Australia

reproduction management packages that this sector will be motivated to promote to its clientele. As such, a critical analysis of the Pregnancy Scanning service sector in the Australian sheep industry is recommended.

Unfortunately, this investigation has resulted in as many new questions as it has answers. However, it is critical that the additional analysis recommended in this report is undertaken if compelling reproduction management packages are to be developed and the reproduction performance of the Australian sheep industry improved either in the current environment or in a possible future environment where lamb and weaner loss is considered an animal welfare issue worthy of market boycott.

Appendix 1: Investigation Methodology

The following methodology was used to guide the investigation the subject of this report:

1. A detailed review of national, state and regional data relating to sheep reproduction efficiency was undertaken to determine geographic and industry trends in sheep reproduction and compare this to other industry data that may influence decisions to focus management practices on these issues. The main data sets that were used to undertake this analysis were ABARE Farm Survey Data (see Appendix 2), Australian Bureau of Meteorology Rainfall Data and various industry and State Department of Primary Industry attitudinal surveys of livestock producers (as referenced throughout the report).
2. An in-depth review of literature relating to extension activities in the area of sheep reproduction from MLA, AWI, DAWA, NSW DPI, VIC DPI, SARDI, QLD DPI and TAS DPI in order to understand the precise nature of current and historic extension programs. This documentation included specific extension program manuals, promotional material, syllabus and independent evaluation reports.
3. Interviews were conducted with key extension staff in each of MLA, AWI, DAWA, NSW DPI, VIC DPI, SARDI, QLD DPI and TAS DPI to triangulate information collected through the literature review and determine how individual programs were delivered and perceptions of their effectiveness.
4. Interviews were conducted with industry experts in New Zealand in order to understand factors that have contributed to improved sheep reproduction efficiency in New Zealand.
5. Under the initial proposal for this project interviews were to be conducted with a sample of producer participants in all existing extension programs as well as producers who have not participated in extension programs. Unfortunately, AWI were not willing to allow the investigators access to participants in their programs. As a result, the investigators used their own contact bases, contacts provided through a seed distribution company and a sample provided by MLA to interview producers that had participated in some extension programs and those that had not (see appendix 4).

6. Produce recommendations to improve adoption of solutions developed by MLA and its sponsored organizations.

Appendix 2: ABARE Farm Survey Data Analysis

This Appendix describes the methodology used to assess historic reproductive performance in the Australian sheep industry.

Process

The following methodology was used to develop an understanding of trends in reproduction efficiency in the Australian sheep industry:

- Marking rates were calculated for all regional sheep enterprise sectors from the ABARE Farm Survey data for each year 1990 through to 2005 by dividing the average number of lambs marked by the average number of ewes mated in each year in each regional enterprise sector. Marking rate was chosen as the measure of reproduction efficiency because of the consistency with which marking rate is formally reported when compared to other measures such as lambing rate and weaning rate. Ideally lambing rate, weaning rate and marking rate would be analysed to identify the precise stage in the reproduction cycle where improvement has occurred. However this data is not routinely collected.
- For each regional enterprise sector the average marking rate for the period 1990-2000 was compared with the average marking rate for the period 2001-2005 in order to identify regional enterprise sectors that had improved average marking rate.
- The annual average marking rate in those regional enterprise sectors that demonstrated improvement in average marking rate is then compared to trends in:
  (a) Number of enterprises in the regional sector
  (b) Average annual stocking rate for the regional sector
  (c) Average labour unit per sheep equivalent for the regional sector,
  (d) Distribution of cross-bred ewes in the regional enterprise sector
  (e) Average annual rainfall for the region
  (f) Average annual Australian retail price of lamb.

The nature of the relationship between marking rate and these factors is then discussed on a regional enterprise basis, regional basis and across industry basis.

Definitions

The ABARE Farm Survey categorises enterprises in the Australian sheep industry as follows:

- *Prime Lamb Specialists* are defined as enterprises that derive at least 20 percent of farm receipts from the sale of prime lamb.
- *Sheep Specialists* are operations where sheep production is the primary focus, excluding prime lamb specialists.
- *Mixed Enterprise Sheep Operations* are operations where sheep is one of several enterprises, where the other enterprises could be other livestock or cropping activities.

These enterprise types can then be categorised as *regional enterprise sectors* according to their geographical location as determined by the Australian Agricultural and Grazing Industries Survey (AAGIS) regions. There are a total of 24 AAGIS Regions across Australia that host sheep enterprises and a total number of 59 regional sheep enterprise sectors. This is demonstrated in Figure X below.

AAGIS Region	State	Prime Lamb	Sheep Specialist	Mixed Enterprise	Total
Western New South Wales	New South Wales	X	X	X	3
Northwest Slopes & Plains	New South Wales	X	X	X	3
New South Wales Tablelands	New South Wales	X	X	X	3
Coastal New South Wales	New South Wales			X	1
Central West	New South Wales	X	X	X	3
Riverina	New South Wales	X	X	X	3
Mallee	Victoria	X	X	X	3
Wimmera	Victoria	X	X	X	3
Central Northern	Victoria	X	X	X	3
Gippsland and Western Districts	Victoria	X	X	X	3

AAGIS Region	State	Prime Lamb	Sheep Specialist	Mixed Enterprise	Total
North Central Queensland	Queensland			X	1
Western & Southwestern Channel Country	Queensland		X	X	2
Charleville-Longreach	Queensland		X	X	2
Darling Downs	Queensland		X	X	2
Eastern Darling Downs	Queensland		X	X	2
Northern Pastoral	South Australia		X	X	2
Mid North, Murraylands and York Peninsula	South Australia	X	X	X	3
Eyre Peninsula	South Australia	X	X	X	3
South East	South Australia	X	X	X	3
Kalgoorlie & Central Pastoral	Western Australia		X	X	2
Northern & Eastern Wheatbelt	Western Australia	X	X	X	3
Central & Southern Wheatbelt	Western Australia	X	X	X	3
Southwest	Western Australia	X	X	X	3
Northern Tasmania, Huon & Midlands	Tasmania	X	X	X	3
				TOTAL	59

Stocking Rate data has been calculated using the ABARE Farm Survey Data by calculating the average area grazed for each regional enterprise sector by deducting the average portion of total area operated that is cropped from the average total area operated. The average number of sheep at 30 June is then divided by the average area grazed. It should be noted that this is not the standard Dry Sheep Equivalent per Hectare measure of stocking rate, as this data is not routinely collected.

Labour Unit per Sheep Unit is calculated using the ABARE Farm Survey data by dividing the average total number of labour weeks by the average number of sheep at 30 June.

Average Annual Rainfall has been calculated using Australian Bureau of Meteorology data by averaging the annual rainfall statistics from the weather stations that cover the specific AAGIS region. In some cases the boundaries are not precise and as such the

actual rainfall statistics for the AAGIS regions may vary from those quoted in this investigation. Furthermore, it should be noted that rainfall at specific localities within a region is frequently highly variable.

Distribution of Cross-bred Ewes will be provided by ABARE provided a reasonable quote for the extraction of this data is provided.

Average annual stocking rate is used as a proxy variable for pasture utilization and feed availability. It is often assumed that if stocking rates are high, reproduction efficiency may be compromised as there is less nutrition per head. However, research demonstrates that individual operations have an optimal stocking rate [ref??]. Average labour unit per sheep unit is a proxy variable for labour availability for managing the sheep enterprise. Generally speaking, one would expect reproduction efficiency to improve with additional labour units to manage the flock. Pasture production and average annual rainfall are proxy variables for feed on ground and generally speaking, the more quality feed on ground, the greater the ability to manage nutrition during the reproduction cycle. It should be noted that both rainfall and pasture production data have significant limitations as proxy variables for feed on ground as neither provide an indication as to pasture quality.