MEAT & LIVESTOCK AUSTRALIA

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Informing future sheep extension strategies to improve reproduction and related welfare outcomes

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Executive summary

The key challenge for the Australia sheep industry in sheep reproduction and related welfare outcomes is to improve lamb survival rates. This project aimed to gain an insight into producer knowledge, attitudes, skills, aspirations and practice in relation to improving reproduction and welfare outcomes, and document the drivers and barriers to adopting best practices that are known to increase lamb survival, such as; pregnancy scanning for multiples, differential management of single and twin bearers by condition scoring, using feed budgets to provide appropriate nutrition, and paddock allocation. The project also sought to understand the various opinions and advice provided by sheep industry service providers in relation to sheep reproduction and the associated management practices. This consultation was undertaken to inform future extension strategies to deliver improved sheep reproduction rates and better welfare outcomes, and to provide a base-line for the current adoption levels of best practice such as pregnancy scanning for multiples. This report also provides a review of the current and likely future gains in lamb marking rates against SISP and MISP targets.

The reproduction situation analysis conducted in this report provides context of the changes in lamb marking rates in the ten years between 2006 and 2016. It was found that Australian lamb marking rates had increased significantly from around 81% to 92% lambs marked to ewes joined, over that period, representing about a 1% gain in marking rate per annum. The key factors contributing to the gains in national marking rates were; a doubling of the number of non-Merino ewes from 15 to 30% of the flock, which consistently mark at least 20% more than Merino to Merino matings; a sequence of best seasons in recent years across south eastern Australia where the majority of the sheep population resides; and the impact of extension programs such as Lifetime Ewe Management and Bred Well Fed Well. Despite the gains in marking rate in the last 10 years, in excess of 12m lambs are still lost in Australia each year, which according to Young et al. (2014), based on 2013 prices were worth over $700m in potential profit. However, based on today's lamb price of $6.00/kg carcass weight, at an industry level the cost of lamb survival is even more profound, estimated to be almost $1b in potential profit lost per year. Furthermore, marking rates dropped substantially in 2016/17 to 85% nationally. In accordance with the significance of this challenge the SISP has a target of ongoing gains in lamb marking rate of 1% per annum to 2020/21 and the MISP identified the down-side risks of continuing high lamb mortality rates such as welfare concerns, potential social license and market access implications for Australian sheep producers.

To inform future extension strategy 386 producers were surveyed, along with 140 pregnancy scanners, 40 ram breeders, and 18 sheep consultants and advisors. The results show that all producer segments surveyed in this project over-estimate current lamb survival rates, at ≥ 80% survival compared to an actual industry average of 70%. Similarly, pregnancy scanners, who of all the influencers of sheep producers are directly engaged to help the issue of reproduction rates, also over-estimate the level of lamb survival at 79%. The only segment with a more accurate understanding of lamb survival rates was the sheep consultants who estimated average survival rates to be 73%. This general lack of awareness of the true levels of lamb loss is a critical issue because building awareness, understanding and discontent in relation to any issue are widely recognised as critical precursors for attitude and behavioral change, without which lamb loss will continue to be an insidious issue.

It was found that only 26% of Australia's ewes are scanned for multiples, which is the primary reason why there is a widespread lack of awareness of true lamb loss. Also producer surveys show that typically only about 80% of those producers scanning for multiples differentially manage singles and twins post scanning, which means in totality that only 20% of Australia's breeding ewes are managed according to their nutritional requirements. This is the primary reason why in excess of 12m lambs are lost in Australia each year, due to either inadequate nutrition to twins or excess nutrition to singles, especially when you consider the producers who adopt pregnancy-scanning for multiples and differential management of singles and twin increase whole-farm lamb marking rates by 14%, primarily driven by improved lamb survival. However, while 80% of Australia's breeding ewes effectively remain un-managed, it is no wonder our national marking rates vary so markedly from year-to-year. This volatility affects not only the individual producers, but the collective industry value chain of both sheep-meats and wool by threatening continuity of supply, which contributes to volatile pricing for our end users.

The core issue is a lack of adoption of recognised best practice for improved reproduction rates, particularly scanning for multiples and differential management of singles and twins. The key reasons for the lack of adoption of best-practice resulting in 80% of Australia's ewes not being managed according to requirements are;

- A lack of recognition of the true level of lamb loss, with all producer segments and producer influencing segments of the Australian sheep industry surveyed, over estimating lamb survival rates, in particular producers that don't scan for multiples (75% of Australian producers),
- A lack of understanding that the majority of lamb loss is under the producers control,
- A lack of awareness that scanning for multiples and differential management of singles and twins significantly improves lamb survival and flock profitability,
- Some producers scanning for multiples not using information to full effect by either not differentially managing singles and twins and/or not effectively allocating resources (feed, shelter, paddocks, labour and fencing) on a whole-farm basis to improve lamb survival,
- Too large of mob sizes of lambing ewes compromising privacy during lambing resulting in poor lamb survival in twins due to exacerbating miss-mothering, and
- Lack of capacity from pregnancy scanners to deliver scanning for multiples with the required accuracy and repeatability and mixed messages from scanners to producers about ewe management and target survival rates for singles and twins due to a lack of understanding,

Another critical issue that is undoubtedly contributing to the lack of adoption on best practice is mixed messages from consultants on the value of scanning and nutritional management to improve lamb survival. In fact, there are some significant sheep industry consultants and advisors actively advocating against the adoption on these practices, with sayings such as 'best profits and best practice never the two shall meet', with particular reference to pregnancy scanning. These messages represent a three-fold problem for an industry trying to improve lamb survival rates. They are (i) making it even more difficult to highlight the degree of the problem (lamb loss) to all sectors of the sheep industry, (ii) perpetuating a message that current practice and associated loss rates is acceptable, and (iii) cast a vale of doubt that leaves producers believing it is not profitable for producers to address lamb survival. This is not only making it more difficult to achieve attitude and behavioural change among non-adopting producers but these messages are also contributing to dis-

adoption of practices such as pregnancy scanning for multiples and differential management of singles and twins, among producers that had embraced these practices.

The consultation in this project highlights that for non-adopting producers the greatest impact on their intent to adopt is evidence that scanning for multiples improves lamb survival and is profitable. Rather than knowing how many lambs are lost between scanning and marking. Therefore, it is imperative as a result of this project that more work is done to prove the virtues of pregnancy scanning for multiples and differential management, and that the cost-benefits are accurately quantified. Also the impacts on whole-farm profitability need to be examined. The outputs from such work would provide a stronger foundation for the industry to promote scanning for multiples and differential management and to quell those with contrary opinions. The scanning demonstration program piloted in and recommended from this project provides the perfect back-drop to undertake thorough cost-benefit analysis and to overtly promote the benefits of best practice on farms that were advised not to adopt. In addition, a study of farms with existing benchmarking data should be undertaken to compare the performance of farms post the adoption of scanning for multiples and differential management compared to those that have chosen not to adopt. A well designed study of this nature would provide irrefutable data on the impacts of scanning for multiples and differential management on whole-farm profitability. It is a matter of urgency to generate economic validation of these practices to use nationally to promote increased uptake of practices that lead to more productive, profitable and ethical sheep farms. The priority on this work exists due to it providing the evidence needed to influence non-adopting producers and to address consultant opinions.

The information gathered in this 'strategy informing project' needs to be integrated with current MLA/AWI priorities to build a cohesive adoption strategy that establishes a learning continuum from awareness to widespread adoption. Currently that learning continuum is limited by a lack of funded adoption activities targeting lamb survival and sheep reproduction. Effectively at present there is Ewe Time Forums and other conferences such as Bestwool Bestlamb for building awareness, 1day workshops/feeder activities such as BWFW and Realising Productive Potential, and one key supported learning package in LTEM. Both the producer's initiatives piloted in this project, Lambs Alive and Scanner Demonstration Project warrant further investment to be rolled out nationally. Lambs Alive provides another supported learning activity to drive improvements in lamb survival on a whole-farm scale and ensure producers are making full of their scanning information. Lambs Alive also fills the void left by LTEM Year 2 being removed, so that LTEM is now only a one-year course, focusing on foundation skills, which no longer has time to fully deal with whole-farm adoption issues, such as paddock allocation for lambing and resources allocation across the entire flock. The Scanner Demonstration Project is both awareness raising and supported learning for non-adopting producers of multiple scanning, which represent 75% of Australian sheep producers. In addition, by targeting producers that have been directly advised not to adopt scanning for multiples and differential management, it will provide a wave of momentum and positive outcomes to combat the consultants and advisors telling producers not to scan.

The industry should be encouraged to invest in interventions to improve reproductive performance, particularly those endeavors targeting extension and adoption. Programs such as Bred Well Fed Well and Lifetime Ewe Management have represented a great investment for MLA and AWI respectively, by delivering profound attitude, practice and performance change that have value added to significant proceeding investments in Sheep Genetics and Lifetime Wool research. Both

programs have reached around one-quarter of the national flock, but continuous improvement is required in content, delivery and administration of these programs.

The survey work undertaken with pregnancy scanners in this project highlights the significance of their reach into the Australian breeding ewe flock and shows the opportunity that exists to have a more informed and skilled network of pregnancy scanners service Australian sheep producers. As a collective these currently only have limited understanding of targets for lamb survival, best practice to be deployed post-scanning or industry training opportunities for farmers. It is recommended to progress the pilot project undertaken with scanners to further develop and test an independent training program for pregnancy scanners. The aim is to improve scanner accuracy and repeatability, and also ensure scanners are providing sound information to producers on targets for single, twin and triplet survival, management of ewes post-scanning and at lambing, and to sign-post producers to the relevant industry programs that are available to support producers. There is a large network of scanners servicing the Australian sheep industry and they have demonstrated a willingness to aid the industry in its challenge of improving lamb survival.

That funding of projects aimed at improving reproduction rates and improving lamb survival be increased substantially to at least double the projected gains from current RD&E to ensure SISP and MISP targets are met. With the current level of funding it is estimated that the industry will only achieve about one-third of the SISP and MISP targets by 2020/21 or 2030. Although reproduction rates and in particular lamb survival are often identified in industry strategic plans as top priorities, if not the top priority, the area continues to be allocated inadequate funding in relation to the enormity of the problem and risk that exists. This issue will remain unless a fundamental change is made in the proportion of MLA/AWI funds allocated to improving reproduction rates. MLA, including the MDC, and AWI need to develop a single 5-year reproduction strategy based on rigorous project evaluation which includes each projects contribution to meta-targets in MISP, SISP and the Wool Strategy. There needs to be more widespread recognition of the importance and impact of reproduction rate and lamb survival on the entire value chain, from producers, to processors, and ultimately consumers.

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1 Background

The on-farm value of sheep meat and wool produced in Australia exceeds $5 billion per annum, despite a national flock of just 42 million breeding ewes, half the number recorded in 1990. In order to ensure consistency of lamb, mutton and wool supply continued improvements in reproduction rates at the farm level are necessary, with the Sheep Industry Strategic Plan (SISP 2015), targeting a 5% improvement by 2020. Prior to 2006 there has been little evidence of improved reproduction efficiency over most of the proceeding 20 years, with the number of lambs weaned per ewe remaining relatively stable at around 80% (Barnett 2007). Whereas in the last 10 years' national lamb marking percentages have improved by about 1% per year, the drivers of which will be discussed in detail in the section on 'Reproduction Situational Analysis'. In order to achieve the targets set in the SISP and the Meat Industry Strategic Plan (MISP 2030), ongoing gains in marking rates of 1% per annum are necessary, which will require an effective strategy that delivers widespread improvements in reproduction rates at the farm level. Furthermore, the current AWI Strategic Plan (2016-2019) has a priority and program directed at improving the marking rates of Merinos.

The main limitation to Australian sheep flocks improving reproduction rates is the degree of reproductive wastage from mid-pregnancy to weaning. More specifically the majority of this wastage (typically >80%) is occurring within 3 days of birth (Brien et al. 2009), known as neonatal lamb survival. It is estimated that over 10 million lambs perish in this period from birth in Australia each year (Trompf et al. 2012). At an industry level the cost of lamb survival is profound, estimated to be in the order of $700m in potential profit lost per year (Young et al. 2014). Lamb survival is a unique challenge that not only poses a significant constraint to production that impacts directly on the ability to sustain turn-off rates while simultaneously trying to rebuild flock numbers but also is a looming welfare issue for the industry, which aligns directly with the significant down-side risk of consumer and community support identify in the MISP. The potential ethical challenges for the Australian sheep industry of the failure of ewes to rear lambs were highlighted in the Victorian DEPI Sentinel Flock Project (2009-12), that reported a loss of over 25% of neonatal lambs at birth. However, in addition to this wastage the study found that two-thirds of the lambs died due to starvation and miss-mothering caused primarily by malnutrition, while a further 17% died due to dystocia caused primarily by excess and imbalanced nutrition in late-pregnancy and lambing.

The difference between lamb survival and many other challenges confronting sheep producers is there are actionable solutions to apply on-farm that are well researched and currently available (www.lifetimewool.com.au), and in addition recent economic analysis has shown that improving lamb survival can contribute to improvements in whole-farm profitability (Young et al. 2014). The Lifetimewool research (www.lifetimewool.com.au) improved understanding of ewe nutrition on ewe and progeny performance and developed guidelines for managing ewes that improve whole-farm profit and animal welfare (Young et al. 2010). With the implementation of these guidelines achieving best practice ewe nutrition and management during pregnancy and lambing, this wastage can be at least halved (www.lifetimewool.com.au). To date these guidelines have been extended to over 3000 sheep producers nationally in Lifetime Ewe Management (LTEM), who have on average achieved an 8% improvement in marking rate. However, there are still many producers both within those that have participated in LTEM and particular outside of that, who have not adopted best

practice management and therefore are not contributing to the gains required in national lamb marking rates.

In addition to lamb losses industry estimates of annual ewe deaths rates are commonly 6% or more, and over 8% in weaners (DEPI Senitinel Flock 2012; Trompf et al. 2012). In fact, weaner mortalities are estimated to cost the industry in excess of $75.8M annually (Campbell et al., 2009; Sheep CRC, 2010).

Despite the economic significance of reproduction, the related production and welfare issues, and well researched solutions, adoption of management strategies to address the loss of lambs, ewes and weaners remains limited (Curnow et al. 2011). For example, only 25% of Australia's breeding ewe flock are pregnancy scanned for multiples annually (Curnow et al. 2014), yet this practice is a critical part of best practice reproductive and nutritional management. This project will provide an update on current levels of adoption of scanning for multiples. Interestingly Barnett (2007) reported that the New Zealand sheep flock, which has widespread adoption of pregnancy scanning for multiples (>85%), had improved reproduction rates by 30 percent over the same period Australia's had remained unchanged. Contributing issues highlighted by Barnett (2007) were the ineffectiveness of communication channels and traditional extension approaches, and mixed messages to producers about the value of reproductive management meaning that existing industry knowledge is not being transferred or best practice being promoted effectively. Furthermore, traditional extension approaches for reproduction were only reaching a relatively small audience. Hence it is imperative to understand why Australian sheep producers have been reluctant to adopt management practices that are being promoted as fundamental to driving optimal sheep reproduction efficiency (Barnett 2007). This project aims to provide at an update on a number of these concerns raised by Barnett (2007) and document the progress made in the last 10 years.

This project will provide insight into the barriers to adoption of best practice among a range of industry segments and identify critical triggers for engagement and practice change to inform future extension strategies that aim to improve reproduction and related welfare outcomes, particularly lamb survival. As well this project will identify the key influencers of producers' for reproductive and welfare management decisions and the significance of the issue relating to mixed messages from consultants, and other sheep advisors, and how this can be overcome. It will also inform industry on community expectations in relation to sheep reproduction and related welfare concerns and how to best demonstrate continuous improvement in these outcomes. A range of interventions will be piloted and evaluated to inform current and future extension strategies on the most effective ways to motivate, engage and influence producers and their advisors to improve reproduction and related welfare outcomes, particularly lamb survival, and how the sheep industry can most effectively interact with the community.

The core challenge for the industry is how to effectively instil a measure to manage culture among sheep producers (see diagram on page 8). This culture is critical to best practice reproductive and welfare management that delivers more productive, profitable and ethical outcomes. Central to this culture is the use of enabling technologies such as pregnancy scanning and feed budgeting. Given that currently less than 10% of sheep producers know the true extent of their lamb loss and even fewer can conduct an energy budget of their ewes (Trompf et al. 2011), a massive change in producer and influencer culture is required. The significance of which is recognised by the leaders of this initiative, who aim to provide industry with pathways to pursue to deliver this cultural change.

This project focuses on MLA's strategic goals of increasing productivity on farm (3.1), and improving reproduction rates. Specifically, this project will inform future sheep industry extension strategy to improve reproduction and related welfare issues, particularly lamb survival. The report also aggregates the estimated impact of current RD&A projects in sheep reproduction and examines the likelihood of the current investment delivering the gains in marking rate (1% increase pa.) that underpin the Sheep Industry Strategic Plan (SISP 2020).

2 Project objectives

The objectives of this project include;

1. Understand producer knowledge, attitudes, skills, aspirations (KASA) and practice in relation to improving reproduction and welfare outcomes, and document the drivers and barriers to adopting best practice,
2. Understand the influencers of producers (eg. consultants, agents, vets, processors) and their KASA and advice in relation to improving reproduction and welfare outcomes, and adoption of industry best practice,
3. Understand community expectations in relation to sheep reproduction and related welfare outcomes,
4. Develop and pilot activities that address the key barriers to adoption, so more producers are engaged and change their KASA and capability to adopt best practice for reproduction and welfare, particularly lamb survival, and
5. Demonstrate improvement in reproduction and related welfare outcomes by evaluating pilot activities and providing robust data on the changes in KASA of producers in relation to adoption of industry best practice.

3 Methodology

This project involved undertaking a series of consultative approaches with a range of stakeholders in the sheep industry, and the wider community to inform future extension strategy. This project engaged with producers from existing MLA and AWI producer initiatives (AWI state networks, primarily BESTWOOL/BESTLAMB, graduates of the LTEM and BWFW programs) and various segments in the wider producer community.

3.1 Objective 1

Understand producer KASA and practice in relation to improving reproduction and welfare outcomes, and document barriers to adopting industry best practice

To address this objective a number of different target groups of producers were surveyed. These groups include;

- State networks, primarily BESTWOOL/BESTLAMB,
- LTEM graduates,
- BWFW participants,
- commercial producers who don't pregnancy scan at all,
- commercial producers from pregnancy scanners databases who only scan wet-dry,
- commercial producers from pregnancy scanners databases who scan for multiples, and

- ram breeders that don't fully evaluate reproduction or carcass traits.

The groups targeted in this project (see diagram on page 6) are recognised as representing significant constituents of the industry and are being targeted for various reasons. For instance, the State Networks are recognised for having a wide range of producers in demographics, enterprise types and innovativeness. While BWFW participants represent a type of producer that elected to attend a 1-day workshop educating producers on nutrition, husbandry and genetic strategies to improve reproduction and welfare outcomes, which presented the opportunity to evaluate the impact of such an intervention. A similar opportunity existed with the LTEM graduates targeted. The State Networks, LTEM and BWFW segments are highlighted blue in the diagram on page 6. The other groups of producers' targeted (highlighted purple) represent segments of the industry that are adopting best practice to varying degrees, which impacts on the industry achieving more widespread uptake.

A series of semi-structured surveys were developed and piloted for each of these groups to collect the KASA and practice of each group, reasons for their current approach to managing reproduction and welfare, and barriers to adopting industry best practice. These are attached as appendices to the relevant previous milestone reports.

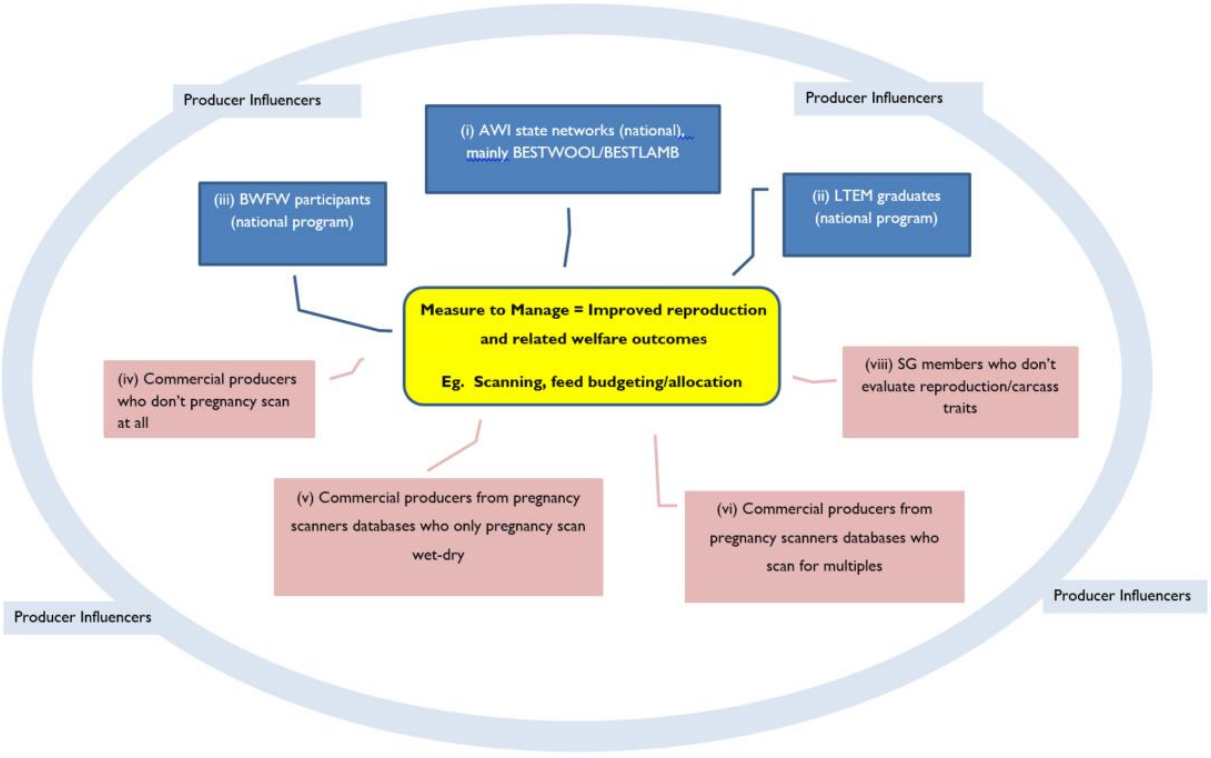

Figure 1. Target segments for market research to understand producer and influencer KASA and practice in relation to improving reproduction and related welfare outcomes, and barriers to adopting industry best practice.

3.2 Objective 2

Understand the influencers of producers (eg. Pregnancy scanners, consultants and sheep advisors) and their KASA/advice in relation to improving reproduction and welfare outcomes, and adoption of best practice

To address this objective different target groups of influencers were surveyed, particularly those that had contrasting attitudes towards promoting management for improved reproduction and related welfare outcomes. The primary groups engaged were pregnancy scanners and consultants, due to their direct dialogue and influence on producers' practices and decisions related to reproduction, from which a total of 100 influencers were surveyed. Surveys were developed and piloted for each of these groups (attached as appendices in previous reports) to collect their current level of engagement, attitude and advice for welfare and reproduction, the basis to their recommendations for managing sheep welfare and reproduction, and their barriers to advocating adoption industry best practice.

The awareness of each of these influencers on industry issues pertaining to welfare and reproduction were canvassed, as will their interest and willingness to assist the industry in addressing these issues. The majority of surveying of influencers was done via telephone interview, although some face-to-face interviews were undertaken.

3.3 Objective 3

Understand community expectations in relations to reproduction and related welfare outcomes

In Australia the vast majority of information collected on the wider community in relation to the sheep industry primarily relates to product satisfaction, such as their eating experience, rather than examining their expectations on the ethics of sheep production and sheep welfare. The aim of this objective is to better understand community expectations in relation to sheep reproduction and related welfare outcomes. In essence we need to understand the community's expectations and how do to best communicate and engage to address their concerns, just as other components of this project are providing the same insight among sheep producers themselves. This will ensure that future industry extension efforts and community engagement approaches are informed by and delivered incognisance with both industry and community expectations.

To date the methodology and the tools required for this objective has been developed, however the 15 depth interviews and 2 focus groups to complete this objective are yet to be completed. MLA will determine if this work will still be undertaken.

3.4 Objective 4

Develop and pilot activities that address the key barriers to adoption, so more producers are engaged and change their KASA and capability to adopt best practice for reproduction and welfare, particularly lamb survival

The activities that were developed and piloted were informed by the outcomes of objectives 1 and 2. These findings will be mapped against the existing learning opportunities/continuum available to sheep producers and gaps identified in the current engagement and learning strategies that are

creating barriers to participation and change. The fundamental premise will be to develop activities that raise awareness of the opportunities to improve sheep reproduction and welfare outcomes and create discontent among producers with the outcomes they are currently achieving. Then provide a range of learning pathways that support change in attitude and practice, and ways to measure/demonstrate the continuous improvement in sheep reproduction and welfare achieved.

3.5 Objective 5

Demonstrate improvement in reproduction and related welfare outcomes by evaluating pilot activities and providing robust data on the changes in KASA of producers in relation to adoption of industry best practice

To evaluate the impacts of the strategies developed and piloted in objective 5. In year 3 of the project participants in the key pilot activities will be surveyed to collect their changes in attitude, practice and performance in relation to reproduction and related welfare outcomes. Analysis will be undertaken on information gathered to assess the effectiveness of different extension strategies. A cost-benefit analysis at the farm level on the value of the changes made to profitability will be undertaken using a tool developed by John Young (Farming Systems Analyst). This will assess whether the gains in reproduction and related welfare outcomes are viable and hence sustainable. These findings will be extrapolated to wider industry for each target segment and an industry cost-benefit derived for interventions piloted.

4 Reproduction Situation Analysis

4.1 Trends in marking rates of the Australian from 2000 to 2015

A review of national reproduction rates and adoption of key practices was undertaken by Barnett (2007). It was reported that in the 15 years prior to 2007 Australia's lamb marking rates had remained stable at around 80%, whilst over the same period the New Zealand sheep industry had increased marking rates by 30%. Since the Barnett review Australian marking rates have risen significantly (by about 1%/annum) to in excess of 90% lambs marked to ewes joined (Figure 2). In fact, the average marking rate recorded across Australia in both 2014-15 and 2015-16 of 92% is the highest recorded in 40 years of records (Figure 2).

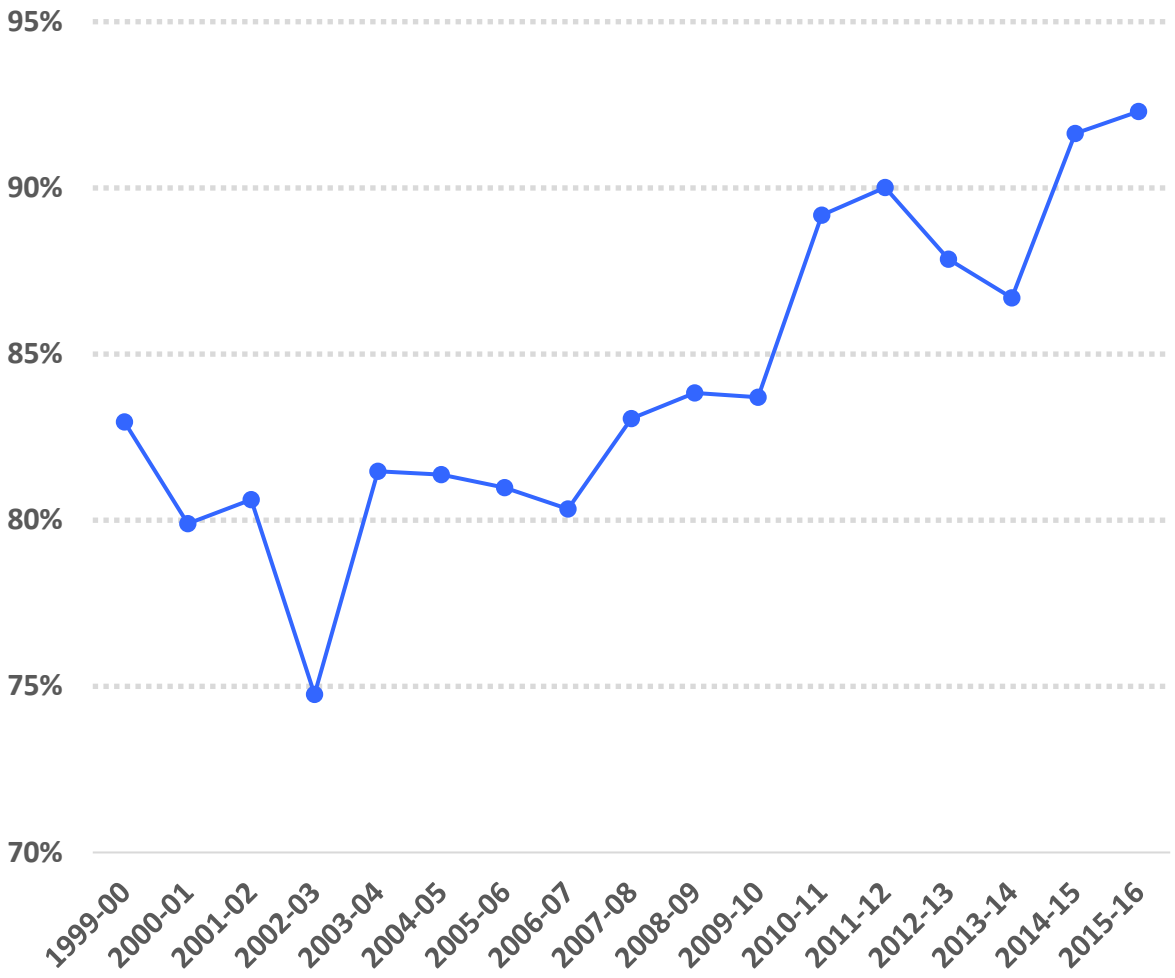

Figure 2. Australian lamb marking rates for all ewe types from 2000 to 2015. (Source: Based on ABS data, analysis by Kimbal Curtis Livestock Dynamics)

To better examine the gains in marking rates and remove the fluctuations that occur in individual seasons, in Table 1, the average marking rate for the five years from 2002/03 to 2006/07 is compared to the marking rate achieved in the last five years, 2010/11-2014/15.

The comparison in Table 1 shows;

- national marking rates have increased by 9% between these two periods examined,
- the states have varied in their marking rate gains from 10% in NSW to 4% in QLD,
- most states had a consistent trend in marking rates in the years studied, with the exception of QLD where the lift in the recent 5-year average was driven by the marking result in 2010/11 alone.

Table 1. Changes in national and state marking rates from 2002/03-06/07 to 2010/11-14/15.

	Australia	NSW	SA	VIC	WA	QLD
Average marking rate 02/03-06/07	81%	80%	86%	86%	80%	63%
Average marking rate 10/11-14/15	90%	90%	95%	94%	86%	67%
Increase in marking rate	9%	10%	9%	8%	6%	4%

(Based on ABS, ABARES and MLA/AWI data, analysis by Kimbal Curtis, Livestock Dynamics, 2016)

4.2 Primary reasons for the gains in marking in the Australian sheep flock

The key factors contributing to the national gains in marking rate of almost 1% per annum over the last 10 years are;

- A doubling in the number of non-Merino ewes in the national flock from 15% to 30% of the flock, which consistently mark at least 20% more lambs than is achieved in merino to merino matings (Figure 3),
- The exception is WA and QLD, where the number of non-Merino ewes had increased to 20% of the WA and QLD flocks, however there was no advantage in marking rate as a result, with non-merino ewes in those states marking the same as merino ewes on average,
- Significantly higher rainfall and better growing seasons in the last 5 years examined compared to between 2002 and 2007, where almost all of NSW, SA and VIC went from receiving decile1-3 rainfall between 2002 and 2007 to at least average or above average rainfall between 2010 and 2015 (Figure 3),
- Whereas rainfall in WA didn't improve over the periods examined and QLD had slight improvement but was variable across the state, and was mainly driven by the 2010/11 alone,
- LTEM had reached over 3,000 producers representing almost 25% of the national ewe flock, lifting their marking rates by 8% on average, as well as reducing ewe mortality by 30%.
- Bred Well Fed Well (BWFW) that had also reached over 3,000 producers (8 million ewes) of which 20% increased marking rate by 9% due to BWFW and 25% when onto LTEM.

To provide a bit more detail, almost 4% of the 9% gain in reproduction nationally is explained by the doubling of non-merino ewes in the Australian flock since 2007, which on average are achieving much higher marking rates than merino ewes joined to either merinos or other breeds (Figure 3).

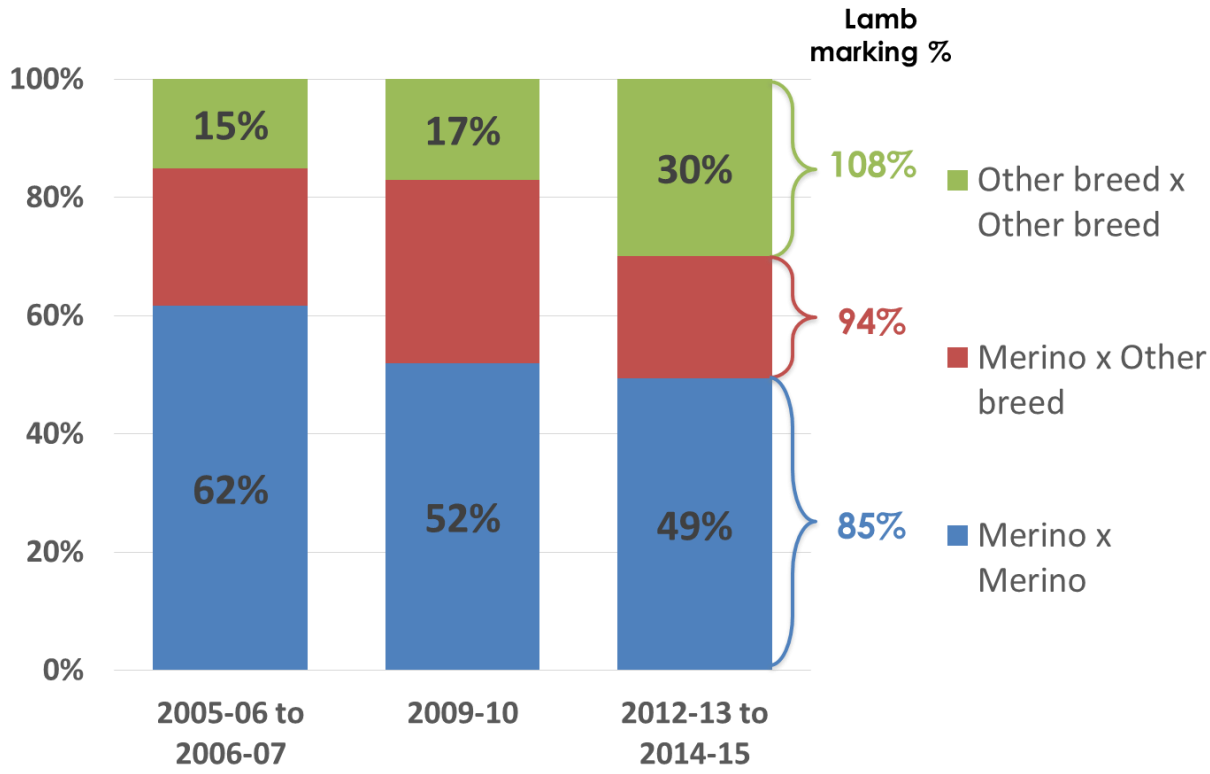

Figure 3. Change in the composition of the Australian ewe flock and the average marking rates in each enterprise type. (Based on ABS and MLA/AWI data, analysis by Kimbal Curtis Livestock Dynamics)

The improved seasons experienced across Australia since 2010 compare to the previous decade are illustrated in Figure 4. In particular south east Australia experienced average annual rainfalls between 2000-09 that were either decile 1 or the driest on record, while since 2010 it has experienced ≥ decile 8 rainfall (Figure 4).

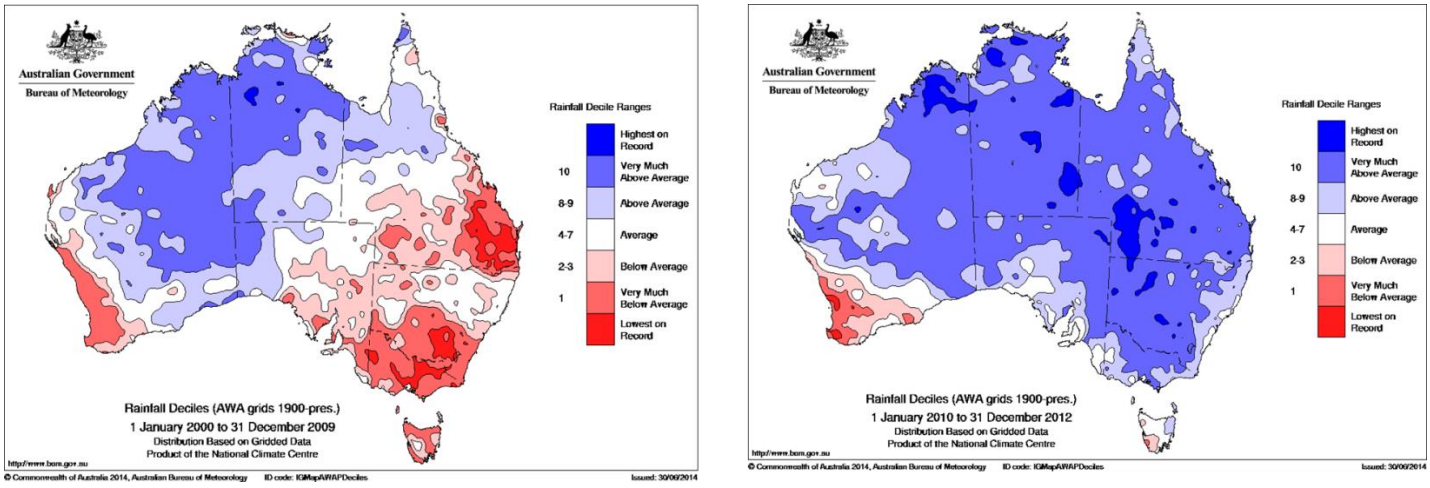

Figure 4. Rainfall decile maps of Australia comparing 2000-09 and 2010-2012.

The combination of the change in ewe flock composition, a run of better seasons and the national expansion of LTEM and BWFW explain the majority of the gains in marking rates over the last 10 years nationally. However, the challenge is to achieve similar ongoing gains in marking rate from 2015 onwards in order to achieve the SISP goals for 2020 and MISP aims for 2030, without

necessarily having continued favourable seasons and without ongoing displacement of merino ewes for non-merino ewes.

4.3 National flock reconciliation for 2016-17 and implications of marking rates

The projected reconciliation of the national flock for 2016-17 based analysis conducted by Kimbal Curtis (Livestock Dynamics) based on SISP assumptions has the flock in a state of equilibrium (Table 2). With the national flock commencing and predicted to finish the 2016-17 financial year with 70 million sheep. This was assuming a marking rate of 94%, which is 2% above the level recorded in 2014-15 of 92%, which was the highest ever recorded in 40 years of records. The assumed marking for 2016-17 (94%) is aligned with the SISP assumptions of 1% higher each year from 2015 through to 2020.

Table 2. Reconciliation of the national flock for 2016-17 based on SISP assumptions.

Opening number of sheep	**70 million**
Number of ewes joined	38 million
Marking rate	94 %
Lambs marked (est.)	**36 million**
Turn off	
Lambs slaughtered	23 million
Sheep slaughtered	8 million
Live exports	2 million
Total turn off (est.)	**33 million**
Losses on farm (~4.0%)	3 million
Closing number of sheep (est.)	**70 million**

(Sourced: based on MLA, ABS data, analysis by Kimbal Curtis, Livestock Dynamics)

Survey data on marking rate collected via the MLA/AWI survey indicates that in 2015-16 the record high marking rates of the previous year (92%) were sustained. However, survey data received to date shows that marking rates in 2016-17 have dropped substantially to 85% (pers. com. Ben Thomas, MLA), primarily due to low marking rates achieved in the late-winter/spring of 2016 during which many south east Australian spring lambing flocks experienced extremely wet conditions and in some areas severe flooding, that resulted in poor lamb survival rates.

The implications of the significant decline in marking rates (7% less) compared to the anticipated rate means that if turn-off rates and on-farm losses remain the same, that the national flock would decline by 3 million to 67 million (Table 3). During 2016-17 a further implication of the low marking

rates has been record lamb prices and more recently record mutton prices, which places processors and consumers under significant price pressure. Hence, the more likely ultimate outcome is that turn-off rates will decline and if they drop by just 10% (3 million head), then this will bring the flock back into equilibrium again, maintaining it at 70 million sheep.

Table 3. Reconciliation of the national flock for 2016-17 based on 85% marking rate.

Opening number of sheep	**70.0 million**
Number of ewes joined	38 million
Marking rate	85 %
Lambs marked (est.)	**32 million**
Turn off	
Lambs slaughtered	23 million
Sheep slaughtered	8 million
Live exports	2 million
Total turn off (est.)	**33 million**
Losses on farm (~4.0%)	3 million
Closing number of sheep (est.)	**66.9 million**

(Sourced: based on MLA, ABS data, analysis by Kimbal Curtis, Livestock Dynamics)

This analysis just highlights how finely tuned the national sheep flock and its entire value chain is to national lamb marking rates. For every 1% change in marking rate, at predicted turn-off rates and on-farm losses for 2016-17, the national flock changes by almost half a million sheep (0.4 million/1% change in marking rate). The imperative to deliver sustained improvements in national marking rates can't be understated for everyone involved in the Australian sheep industry. Albeit, some producers would argue that the record high prices are a positive outcome of low marking rates, however it is very concerning the impact this may have on consumption levels of both lamb and mutton. At the end of the day marking rate, and in particular lamb survival, is a production, economic and ethical challenge that affects the entire value chain.

5 Understanding the adoption of best practice and impact of current programs

The best practice package for sheep producers for improving reproduction and related welfare outcomes is becoming more defined with understanding gleaned from research, development and extension being undertaken across Australian sheep industry. Key research projects such as Lifetime Wool and Lifetime Maternals have taught us a lot about ewe condition score profile management to improve reproduction and welfare outcomes, in particular the impact of pregnancy nutrition on the survival of singles and twin born lambs and their dams, and the impact of feed-on-offer in lambing paddocks on the survival of newborn lambs. Work undertaken in projects such as the Vic DPI Sentinel Flock Project and by Gordon Refshauge (NSW DPI) has improved our understanding of the primary causes of lamb loss, such as starvation and miss-mothering and dystocia issues, and provided insights into how to mitigate these problems to improve lamb survival rates. Current research into the impact of lambing density (ewe mob size and stocking rate) is providing new understanding of the lambing paddock environment and how to minimize miss-mothering of twin born lambs. In addition, the exchange with well over 3,000 producers in each of LTEM and BWFW and the evaluation data collected provides the opportunity to validate what practices are resulting in significant gains in the number of lambs weaned on commercial sheep properties. For instance, the most recent evaluation of LTEM shows that participants that adopt scanning for multiples and differential management of singles and twins increase whole-farm number of lambs weaned by 14% compared to the average across all graduates of half that (7%).

In Table 4 below a brief summary of the key components of best practice for adult ewes at each stage in the ewe's reproduction cycle has been assembled. This table doesn't detail all the individual practices that under-pin best practice, but provides an overview of the whole reproduction cycle.

Table 4. Stage of the ewe's reproduction cycle and related best practice

Stage of the reproduction cycle	Best practice
Ewe recovery (between weaning and re-joining)	• Joining length of 5 weeks or less (unless joining prior to January then 7 weeks or less) • Wean at 12-13 weeks from the start of lambing (unless joining for 7 weeks then wean at 14 weeks) • At weaning draft of the lite condition score (CS) ewes and manage preferentially while quality feed available
Joining	• Manage ram CS to target 3.0-3.5 and ram health (worms, flies and feet) from >10 weeks prior to joining to lift semen production, quality and improve ram mobility • Target CS 3.0 plus in ewes at joining to lift conception rates and set ewe up for ensuing pregnancy • If achieving high twin lamb survival rates (>75%) can lift conception rates by flushing ewes on green feed or Lupins for 1 week prior to joining and 1 week into joining • Joining length of 5 weeks or less (unless joining prior to January then 7 weeks or less)
Early to mid-pregnancy (Day 0 to 90 of pregnancy)	• Manage Merino ewes to maintain CS joining and scanning for placental development to aid twin lamb birth weights, only ever allow CS loss if it can be regained before lambing • Maternal ewes can be managed to loose CS from joining to scanning so long as not less than 3.0 at scanning

	• For all ewe types target condition score 3.0 at scanning
Late-pregnancy to lambing (Day 90 to 150 of pregnancy)	• Pregnancy scan ewes for dry, singles, and multiples, at day 80-90 of pregnancy, once scanning over 160% identify triplets • Manage twin and single bearing ewes differentially immediately post scanning to tailor nutrition to singles and twins so Merino twins lamb in 0.3 CS higher than singles and Maternal twins lamb in 0.5 CS higher than singles • Manage Merino twin bearing ewes to maintain CS from scanning to lambing for to lift twin lamb birth weights • Merino ewes target CS 3.0-3.3 for twins at lambing and CS 2.7-3.0 for singles at lambing • Maternal ewes target CS 3.0-3.5 for twins at lambing and CS 2.6-2.8 for singles at lambing • Prepare lambing paddocks
Lambing to marking (Day 0 to 50 of lactation)	• Lamb Merino twins in 12-1500 kg DM/ha high quality pasture • Lamb Merino singles in 9-1100 kg DM/ha moderate quality pasture • For all ewe types lamb twin in smaller mobs than singles • For all ewe types allocate twins to paddocks with the most protection, privacy, least predation, best past results and try to allocate twins to pastures with highest legume content • If lamb survival rates are typically poor collect and weigh a sample of dead lambs, twins should weigh > 8% of the ewes standard reference weight and conduct post-mortem to determine cause of death and identify ways to rectify in future • Keep accurate lambing records by mob and paddock and use information to inform future paddock allocation for lambing • If lambing mobs boxed prior to lamb marking to aid pasture utilisation count lambs in one of the mobs prior to boxing • Manually wet and dry the ewes at lamb marking and identify ewes that have failed to rear lambs, cull if have udder defects
Lambing marking to weaning (Day 50 to 90 of lactation)	• Provide between 1200-2500 kg DM/ha of high quality pasture to lactating ewes, ensuring best quality pastures go to twins • Imprint feed lambs on their mothers with the feed and water supply they will be exposed to post-weaning • Wean at 12-13 weeks from the start of lambing (unless joining for 7 weeks then wean at 14 weeks)

There is a comprehensive array of practices that combine together for best practice reproduction and related welfare management. The list in Table 4 does not include other related best-practice management areas such as pasture management, which includes;

- soil testing to identify the major limitations to plant growth and applying the required nutrients,
- developing and managing productive pastures that grow the quality and quantity of feed, with the timing necessary, to provide nutrition to the breeding ewe thorough the reproductive cycle,
- deferred grazing or containment feeding to build a feed wedge to increase pasture growth rates and meet lambing feed-on-offer targets, and
- strategic use of growth promotants such as Urea and/or Pro Gibb to increase pasture growth rates.

The purpose of briefly documenting some of the key components of best practice reproduction management (have not included any genetic components) was to remind readers of the complex nature of reproductive management. The complexity involved is undoubtedly a contributing factor to the low levels of adoption of best practice among the broader sheep producer population, but despite this programs such as LTEM and BWFW have been proven to profoundly change producer adoption rates and increase whole-farm number of lambs weaned. This section will report on the adoption of best-practice among various producer segments targeted in this study and examine the impact LTEM and BWFW have had on best-practice reproduction management, the barriers that exist among some producers, as well as outlining the findings from influencers (pregnancy scanners, consultants and stud breeders). Also discussed in this section are the factors influencing the degree of impact of LTEM on producers to inform future extension endeavours such as MLA's new Profitable Grazing Systems program.

5.1 Producer survey

A very comprehensive survey was conducted with producers. Three hundred and eighty-six producer surveys were conducted, from which 311 were fully completed. The number surveyed in each segment compared to the target number to be surveyed is summarised in Table 5. There is a small shortfall in the number of respondents in the wet-dry pregnancy scanning category.

Table 5. The target number of respondents across the different segments and the number of surveyed participants achieved to date.

	Total	LTEM grads	BWFW grads	Non-scan	Wet-dry scan	Multiple scan
Target number	400	50	100	50	50	50
Achieved	386	143	121	80	46	185

The majority of the survey respondents were from Victoria and originate from the BESTWOOL/BESTLAMB network (Figure 5). Also about half (54%) of the respondents are from the medium rainfall zone (450-650mm) and the lowest number (18%) are from the high rainfall zone (>650mm) and the balance (28%) are from the low rainfall zone (<450mm).

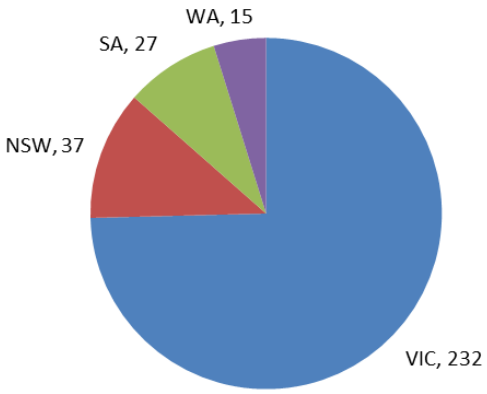

Figure 5. The number of respondents segregated on a state basis.

Eighty of the 311 respondents did not pregnancy scan which equated to 26% of the total number of responses and a further 15% of respondents only wet and dry ewes (Table 6). For further analysis, these two groups (totalling 126 respondents) were combined into one segment as 'non-scanners' due to the inability of the wet-dry category to adopt any additional best practices that involved management of single and twins separately or calculation of lamb survival rates. In the 'scanners' group 165 scanned for multiples, while a further 20 respondents scanned for multiples and also undertook foetal aging. Classifying respondents in the two groups, 'non-scanners' and 'scanners', resulted in 126 and 185 respondents respectively.

Table 6. The pregnancy scanning practices undertaken by respondents.

Category	Respondents (n)	Proportion (%)	Analysis group
Non-scan	80	26	Non-scanners
Scan - wet/dry	46	15	Non-scanners
Scan - multiples	165	53	Scanners
Scan - foetal age	20	6	Scanners

The 'non-scanners' group were asked what impact different aspects of pregnancy scanning would have on their decision to implement pregnancy scanning for multiples in the future (Table 7). When their responses were ranked the aspects that had the greatest impact (ranked high or very high impact) on the decision to scan for multiples were 'evidence that it helps improve lamb survival' and 'proof that scanning for multiples improves efficiency and profitability'. Interestingly, 'knowing how many lambs are dying' and 'information on the cost-benefit of scanning', would have the least impact (ranked no or little impact) of the future decision to adopt scanning.

Table 7. The percentage of responses from 'non-scanners' when asked what impact the following statements would have on their motivation to adopt pregnancy scanning for multiples

	Limited or no impact	Moderate impact	High to very high impact
Evidence that scanning for multiples helps improve lamb survival	11	24	**65**
Proof scanning for multiples improves efficiency and profitability	13	29	**58**
Scanning for multiples saves time rather than creating more work	26	24	51
More cost effective use of supplements available	20	34	46
Scanning for multiples is worthwhile even with limited paddocks	21	34	45
Information on the cost-benefit of scanning for multiples	**32**	40	28
Knowing how many lambs are dying by comparing fetal numbers to lambs marked	**38**	24	**39**

The top and bottom ranked aspects in Table 7 provide similar outcome in terms of information but have been rated very differently by respondents in terms of their impact on future adoption decisions on scanning for multiples. The most logical explanation for this contrast in impact is 'knowing how many lambs are dying' doesn't actually tell producers how to fix the problem and is a more negative statement. In comparison 'evidence scanning helps improve lamb survival' implies that it helps solve the problem and is a more positive statement. Another explanation is the respondent's knowledge that pregnancy scanning is a key step in calculating lamb survival may simply be missing, which is also demonstrated by the fact that they did not associate the 'cost-benefit of scanning' with 'proof that it improves efficiency and profitability'. It may be that the 'non-scanners' have deficiency in the basic knowledge and or attitudes that dismiss the practice of pregnancy scanning as an important process in improving lamb survival and profitability.

Lamb survival

A general hypothesis is that producers that are not pregnancy scanning for multiples and who by default do not have the information to calculate their actual potential number of lambs at scanning, are overestimating their lamb survival rates. All survey respondents were asked to estimate their typical lamb survival rates (Figure 6). From these results, it can be seen that about 46% of 'non-scanners' estimate that they have greater than 90% survival, which is almost 20% more than those pregnancy scanning for multiples.

There was a similar proportion of respondents from both groups for the 81-90% survival category, however more than double the number of the 'pregnancy scanners' group, estimated their lamb survival to fall into the 71-80% survival category compared to the 'non-scanner' group.

There is a clear difference in the distribution of the responses between the 'non-scanners' and those pregnancy scanning for multiples. The 'non-scanner' category significantly over estimate lamb survival. Lamb loss appears to be insidious for producers unless they quantify the exact difference in total foetuses and the number of live lambs marked. Interestingly, even some of the respondents that pregnancy scan for multiples also appear to be over estimating lamb survival. Further analysis will compare the estimates of lamb survival with specific raw data on the scanning and marking data from these respondents.

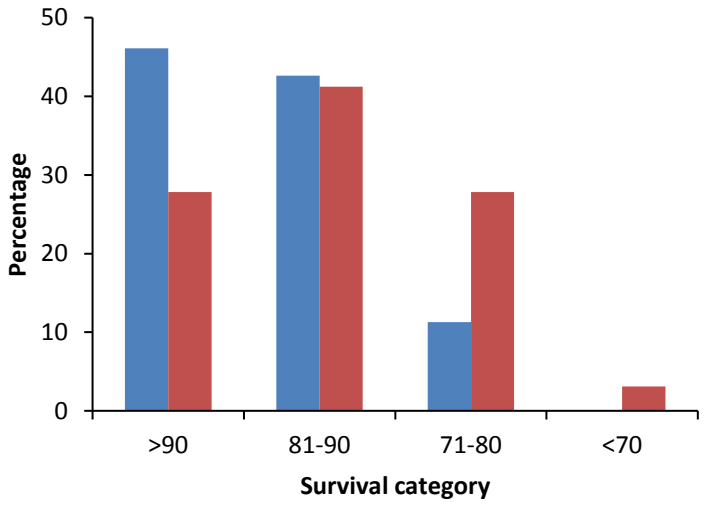

Figure 6. The lamb survival estimates from birth to marking for non-scanners (blue bar) and those pregnancy scanning for multiples (red bar).

Even though 'non-scanners' were potentially overestimating survival, when asked to estimate their trend in lamb marking rates (Table 8) they had a higher proportion of respondents that said their marking rate had remained unchanged (32% versus 20%). Twenty percent of 'non scanners' were also less likely to have increased marking rates by 10% or more when compared to those producers that scan for multiples.

Table 8. The trend in lamb marking percentage among non-scanners and scanners.

	Declined	Same	Increased 5%	Increased >=10%
Non-scanners	2	**32**	32	**35**
Scanners	2	**20**	23	**55**

From the 311 surveys completed, 185 respondents were identified as pregnancy scanning for multiples. From these 185 respondents, 150 calculated lamb survival rates, 35 said they did not calculate lamb survival rates. The fact over 80% of the producers scanning for multiples went on to calculate lamb survival rates is a very positive outcome. Respondents were further asked what the impact of knowing the lamb survival rate had on their ambition to improve lamb survival (Table 9). From these responses 83% of producers rated that knowing lamb survival rates had a high to very high impact on their motivation and desire to improve lamb survival. Furthermore, 69% of respondents said that knowing their lamb survival rates had a high to very high impact on them adopting or trialling other practices aimed at improving lamb survival. For those producers already scanning it is clear that a key factor in the desire to improve lamb survival is understanding the amount of loss that is occurring.

Table 9. The percentage of responses when asked 'what impact has knowing your lamb survival rates had on the following' (1= no impact; 5 = very high impact).

Category	1	2	3	4	5
Increasing your motivation/desire to improve lamb survival	0	1	17	**47**	**35**
Leading you to adopting/trialling other practices aimed at improving lamb survival	2	5	24	**47**	**22**

All respondents were asked to identify from a set list the barriers to improving lamb survival (Table 10). From these responses there was four barriers that received more responses than the other barriers listed. These were, 1) 'lack of feed available at lambing', 2) 'my farm has bad weather', 3) 'not enough paddocks to split up ewes for lambing' and 4) 'lack of labour available'. All four barriers ranked higher than other barriers in both the scanning groups. However, for all these barriers they were regarded more significant in the multiple scanning group than the 'non-scanners'. This is most likely an indication that these barriers are more prominent for producers who are scanning and are more aware of the constraints in the farm system post scanning.

Further analysis is required to fully elucidate the significance of these results in comparison with open ended questions, considering that multiple barriers could be selected by respondents, yet the percentage of responses for the four main barriers were relatively small compared to the overall number of responses that potentially could have been given. This may indicate that factors other than those listed may be more important and the open ended answers may provide other factors that were not considered in the initial design. The analysis of open ended questions will be completed once all surveys have been conducted.

Table 10. The percentage of respondents for each barrier category when asked "which of the following are barriers stopping you from improving lamb survival" and seperated into non-scanners and those respondents scanning for multuples.

Barrier	Non-scan	Scan
Lack of feed available at lambing	**15**	**19**
My farm has bad weather at lambing	**12**	**18**
Not enough paddocks to split up ewes for lambing	**13**	**17**
Lack of labour available	**12**	**11**
Not sure how to improve it	7	8
Too costly to put in more paddocks for splitting up ewes for lambing	3	7
Requires too much time and effort	7	5
I've never measured my lamb survival (don't know where I am at)	7	4
Often box up mobs prior to lamb marking so can't collect marking result for each mob	1	3
Been increasing my paddock size for more efficient cropping	6	3
Sheep are not my main focus	5	2
My lamb survival rates are already high, so there's not much room to improve	3	2
Pregnancy scanning is too costly	3	1
Improving twin lamb survival is hard work and is not worth the effort	3	1
Too busy at lamb marking to collect marking percentages per mob	1	1
Don't believe lamb survival is a profit driver for my enterprise	1	0
Don't believe lamb survival can be improved on my farm	1	0

Drivers and barriers to adopting best practice

A stepwise approach was employed to compare the drivers and barriers between groups that differed in their adoption of various practices. Filters were applied to key best practices sequentially to form groups based on best practice (Table 11). For example, from the total number of respondents only 22 producers undertook all best practices listed in the table.

Similar to the previous findings, it can be seen that once producers adopt pregnancy scanning for multiples they often progress to adopt other practices such as managing single and twins separately

during pregnancy and lambing. A further drop-off in producers occurred when they had to use metabolisable energy charts to calculate an animal's energy requirements. Finally, there was only a small proportion of respondents (n=22 or 7%) that wet and dry ewes during lactation or at lamb marking after undertaking the preceding practices.

Table 11. The stepwise reduction in the number and percentage of respondents as they cumulatively undertake key best practices.

Practice	Respondents (n)	Percent
Total	311	100
Pregnancy scan for multiples	185	59
Manage single and twins separately during pregnancy	172	55
Separate single and twins for lambing	167	54
Lamb twins in smaller mob sizes	150	48
Use ME charts to calculate animal requirements	61	20
Wet and dry ewes during lactation or at lamb marking	22	7

All respondents were asked to rate their skill levels for a range of practices. These skill assessments have been segregated into four contrasting segments highlighted in Table 11 (non-scanners, scanners, use of ME charts, wet-dry ewes) based on their level of adoption of best practice (Table 12). As the uptake of best practice increased the respondents generally ranked their skill level in each of the practices at a higher level. Most notably was the lower rating given for calculating ME balance using charts and interpreting and understanding FeedTest results for the non-scanning segment. Also of note is the jump in the mean results from the movement from scanning multiples to the use of ME charts. For most practices producers rated their skill level higher if they were in the category that used ME charts. There was no discernible difference in the skill ratings moving from the segments using ME charts to the wet-dry category.

This emphasises that for producers to adopt pregnancy scanning they may need to understand the differences in energy requirements between classes of livestock to derive the full benefit of pregnancy scanning. However, in order to understand differences in energy requirements they may also require a prior understanding of the units of measurements and standard language used to describe energy requirements of different classes of livestock, supplementation and pasture. Acquiring these basic skills and knowledge in understanding simple "energy in" and "energy out" concepts may create a cascading effect for the adoption of higher order management practices that improve lamb survival. In other words, these are critical skills to enable producers to differentially manage ewes post scanning and throughout lambing to improve lamb survival.

Table 12. Mean results for the different segments when asked to rate their skill level for a range of practices (Scale 1-5, 1=low skill; 5=high skill).

	Non scan	Scan	ME charts	Wet dry
Interpreting & understanding FeedTest results	3.0	3.5	3.8	3.8
Estimating pasture quantity and quality	3.1	3.3	3.5	3.6
Condition scoring	3.7	3.9	4.1	4.2
Calculating the metabolisable energy(ME) balance using charts	2.7	3.2	3.7	3.7
Managing ewes to achieve target condition scores at key times	3.3	3.7	3.9	3.9
Managing a higher stocking rate system	3.1	3.3	3.4	3.4
Making precise supplementary feeding decisions	3.2	3.3	3.7	3.7
Allocation mobs to paddocks based on FOO/Quality and the ewes needs	3.4	3.8	4.0	3.9

Respondents were also asked to rate their current performance for a range of production metrics (Table 13). Generally, the four best-practice categories were similar in how they ranked their current performance. However, the non-scanning category ranked their current performance for lamb marking percentage above their actual current performance for lamb marking. This is most likely because they are happy with their current level of performance and are oblivious to the level of losses occurring from scanning to marking. A critical driver of behavioural change is 'the level of discontent a producer has with their current situation' or 'their recognition that there is a significant opportunity to improve'. This will be a key challenge to establish extension strategies that build momentum for change in non-adopting producers.

Table 13. Mean results for the different segments when asked to rate their current performance for a range of production metrics (Scale 1-5, 1=low skill; 5=high skill).

	Non scan	Scan	ME charts	Wet dry
Stocking rate	3.4	3.4	3.5	3.7
Lamb marking percentage	3.5	3.4	3.4	3.3
Managing ewe condition to achieve targets	3.4	3.6	3.7	3.7
kg wool/ha	2.9	2.9	3.0	2.9
kg lamb/ha	3.0	3.2	3.2	3.0
Ewe survival rates	3.5	3.6	3.6	3.4
Weaner survival rates	3.4	3.6	3.6	3.4
Lamb survival rates (at birth)	3.2	3.2	3.2	3.1
Wool cut per head	3.2	3.1	3.2	3.1
Lamb growth rate (birth to sale)	3.2	3.3	3.3	3.1
Lamb turnoff weight	3.4	3.5	3.4	3.2

When the respondents were asked to rate their desire to improve the same production metrics, the non-scanners had a lower desire to improve both lamb marking and lamb survival than all the other segments (Table 14). This could be a function of their relative ignorance, or more importantly the awareness/belief the other segments have of the importance of these metrics in terms of the importance of lamb losses and resultant lamb marking rates to the profitability of their enterprise. Also of note was the greater desire of the 'Scan', 'ME charts' and 'wet-dry' categories to improve the kilograms of lamb per hectare, lamb growth from birth to sale and lamb turnoff weight.

The respondents were also asked to rate how much they cared about lamb survival in a separate question (listed in Table 14). This was ranked highly by all segments in absolute terms, but the non-scanners had a lower rating than the other segments.

Table 14. Mean results for the different segments when asked to rate their desire to improve for a range of production metrics (Scale 1-5, 1=low skill; 5=high skill).

	Non scan	Scan	ME charts	Wet dry
Stocking rate	3.6	3.7	3.8	3.9
Lamb marking percentage	4.0	4.4	4.4	4.4
Managing ewe condition to achieve targets	3.6	3.9	3.9	3.6
kg wool/ha	3.4	3.4	3.4	3.4
kg lamb/ha	3.7	4.3	4.3	4.6
Ewe survival rates	3.9	4.0	3.9	3.9
Weaner survival rates	3.9	3.9	3.8	3.8
Lamb survival rates (at birth)	4.1	4.5	4.5	4.7
Wool cut (kg/head)	3.4	3.4	3.3	3.0
Lamb growth rate (birth to sale)	3.9	4.5	4.6	4.7
Lamb turnoff weight	3.9	4.2	4.2	4.2
How much do you care about improving lamb survival	4.4	4.7	4.7	4.8

5.2 LTEM impacts on best practice adoption and factors influencing impact

The LTEM program was developed in 2005/06 based on a combination of the findings from two AWI-funded research projects. The Lifetime Wool (LTW) project quantified the impacts of nutrition throughout the reproductive cycle on ewe and progeny performance, which provided the scientific content for LTEM. Simultaneously research evaluating the impacts of the paired-paddock program (Triple P) on producer attitudes and practice provided the foundation for the extension strategy underpinning LTEM. LTEM commenced in Victoria in spring 2006 and was subsequently expanded nationally in 2009. The program is based on groups of 5 to 7 producers that meet 6 times per year with a trained facilitator. During these hands-on sessions, the group visits each participating farm and learns skills in condition scoring, pasture assessment and best practice ewe and lamb management to increase reproduction efficiency and wool production, mainly through reducing ewe and lamb mortality.

The objectives of LTEM are to:

- improve producer understanding of the impact of ewe condition and nutrition on ewe and progeny performance,
- develop producer skills and confidence to adopt LTW management guidelines, and

- demonstrate on participating properties with their sheep that the guidelines developed by LTW for the management of ewes and their progeny are practical and profitable.

Previous evaluations have identified a series of attitude, skill and practice changes that enable LTEM to achieve its objectives. More specifically in order to maximise the impact of LTEM on participants the key pillars of change include:

(i) changing **attitude** to the importance of managing ewe condition score as a driver of farm profit,
(ii) changing **skills** to manage ewes to achieve condition score targets at key stages throughout the reproduction cycle that cost-effectively improve weaning rates,
(iii) changing adoption of management **practices** including pregnancy scanning for multiples and differentially managing twin-bearing ewes, and these link to deliver
(iv) the resultant **impacts** on weaning rate.

Increasing the proportion of farmers that differentially manage twin-bearing ewes is without doubt the **key practice change** that has the most profound impact on weaning rates by LTEM graduates and remains the ultimate challenge of the program.

A comprehensive evaluation of impacts has been undertaken on graduates since the program began and the overall impacts are summarised here. The average participant in LTEM manages over 3,300 ewes and since the program began 3000 producers have graduated, which in total constituents 10 million ewes or 25% of the national breeding ewe flock. On average, these participants have increased stocking rates by 11% (9 vs. 10 DSE/ha), increased whole farm lamb marking percentage by 7% (98 vs. 105) and reduced adult ewe mortality by 33% (4.2 vs. 2.8%). The combined increase in stocking rate and lamb marking percentage has increased the number of lambs marked per hectare by about 20%. Albeit the impacts on graduates in the last 4 years (2014-17 inclusive) have been less than half that of LTEM participants graduating in the preceding 4 years (2010-13 inclusive), which is extremely concerning given the significance of LTEM for achieving national reproduction targets.

The productivity gains achieved by participants of LTEM can be attributed directly to changes in their use of management practices including managing pastures, managing ewes and their nutrition and measuring performance (Table 15). In particular, it was found that LTEM participants who adopted both scanning for multiples and differentially managing singles and twins increased whole-farm marking rates by 14%, which is double the average gain in marking rate among LTEM graduates.

Table 15. Change in the proportion of LTEM participants adopting key components of best practice reproduction management prior to and after LTEM.

Management practice	Prior to LTEM (%)	After LTEM (%)	Difference
Assessing pasture quantity and quality	32	88	56
Condition scoring ewes	22	91	69
Pregnancy scanning for multiples	26	65	39
Differentially managing singles and twins	20	62	42
Energy budgeting- calculate ME balance and rectifying	2	70	68
Quantify lamb survival rates	18	64	46

In a supported learning program like LTEM the deliver is an integral part of the program and has a major impact on the outcomes achieved. Based on examination of evaluation data on LTEM graduates from 66 different LTEM deliverers (Table 16) it was found that;

- 22 of the deliverers (the bottom-third) had no impact on lamb marking rate, in fact whole-farm marking rate after LTEM was -1% lower than prior to LTEM,
- 44 of the deliverers (the bottom and middle-thirds) delivered impacts on marking rate that were below the average change in marking rate across all LTEM graduates of +7%, and
- 22 of the deliverers (the top-third) had a profound impact on lamb marking rate, in fact whole-farm marking rate after LTEM was 15% higher than prior to LTEM, which is over double the average change in marking rate across all LTEM graduates of +7%.

Table 16. Impact of deliverer on the change in whole-farm marking rate of LTEM participants prior to and after LTEM.

Deliverers ranked on impact	Marking rate prior to LTEM (%)	Marking rate after LTEM (%)	Change in marking rate (%)
Bottom-third of deliverers (n=22)	98	97	-1
Middle-third of deliverers (n=22)	99	105	+6
Top-third of deliverers (n=22)	91	106	+15
Average of all LTEM graduates	98	105	+7

This data highlights that it is possible to significantly improve whole-farm marking rates when supported learning packages with effective content and enabling tools are delivered by quality deliverers. In order for the sheep industry to achieve a high return on investment for all stakeholders in extension programs each of these ingredients must be evident.

5.3 BWFW impacts on best practice adoption

Bred Well Fed Well (BWFW) is a practical, one-day workshop which highlights the key production benefits of genetics and nutrition for improved performance, particularly reproduction. The objectives of BWFW are to;

- Increase producer knowledge of the impacts of ewe nutrition on ewe and progeny performance, animal welfare and farm profit,
- Increase awareness and knowledge of how ASBVs can be used to achieve enterprise objectives and reduce the perceived complexity of the technology and identify opportunities for producers to begin using ASBVs, and
- Encourage at least 10% of participants to progress on to participating in further training.

BWFW commenced in December 2011 and to date (September 2017) there has been a total of 3879 participants attending a total of 158 workshops with an average of 25 people per workshop (Table 18). Graduates are surveyed 9-12 months after attending the workshop and the impacts on management practices related to improving reproduction rates are summarised in (Table 17).

Table 17. Change in the proportion of BWFW participants adopting key components of best practice reproduction management prior to and after BWFW.

Management practice	Prior to BWFW (%)	After BWFW (%)	Difference
Condition scoring ewes throughout the year	30	80	50
Draft ewes based on CS and manage separately	19	40	21
Manage ewes to achieve CS targets at key times	58	85	27
Assess pasture quantity and quality	63	77	14
Feed budgeting for ewes	35	61	26
Adjust supplement feeding	68	77	9
Scan for multiples	44	62	18
Manage single and multiple bearing ewes separately	40	58	18
Allocate to paddocks based on FOO and ewes needs	64	77	13
Quantify lamb survival rates- scanning v's marking	39	61	22

The data presented in Table 17 shows that it is possible to achieve practice change as a result of a one-day workshop, with the increase in adoption of condition scoring (+50%) among BWFW graduates comparing favourably with that achieved among LTEM graduates (+56%) presented in Table 15. However, across the range of practices measured the degree of change as a result of BWFW was understandably lower than LTEM nevertheless adoption of best practice has increased due to BWFW. Also significant increases in the use of ASBVs were recorded among BWFW graduates.

BWFW graduates were also assessed for changes in marking rate. It was found that 20% of BWFW believed they had changed marking rate solely as a result of the BWFW workshop and their average gain in marking rate was 9%. An additional objective of BWFW was to encourage participants onto further learning opportunities. It was found that since BWFW commenced 961 expressions of interests (EOIs) to participate in LTEM had been recorded at the end of the BWFW workshop, which represents 25% of total BWFW participants (Table 18). However only 207 participants that expressed interest in LTEM and have gone onto participate in the course, which only represent 5% of the total number of BWFW participants (Table 18). Hence only 22% of the EOIs to undertake LTEM were converted into LTEM participants, while the 754 EOIs that have not been converted into LTEM participation represent a significant opportunity for additional LTEM groups.

This data shows that BWFW can be both an effective program for delivering practice change and an effective feeder program that motivates producers to do further training. A key to success for recruitment into the next learning experience is to have a defined offering of value, however specific attention must be given to the follow up of producers that express interest in that further training.

Table 18. Participation in BWFW since it commenced and conversion of EOIs into LTEM.

Year	Number of workshops	Total BWFW participants	LTEM EOIs received	EOIs converted into LTEM	Conversion of EOIs to LTEM (%)	Number of EOIs not converted
2012	58	1665	381	46	12	335
2013	30	816	246	66	27	180
2014	34	752	162	51	31	111
2015	14	293	34	7	21	27
2016	22	353	60	17	28	43
Unknown dates/locations on EOIs			78	20	26	58
Total	**158**	**3879**	**961**	**207**	**22**	**754**

5.4 Pregnancy Scanners – adoption of best practice reproduction

A total of 92 pregnancy scanning businesses, which represented 140 practicing scanners across Australia, were surveyed and the data in Table 19 reports in detail the pregnancy scanning conducted in each state. Nationally a total of 15.87 million ewes are pregnancy scanned, which represents 40% of the national ewe-flock of 39.4 million (Table 19- round brackets). However, the proportion of ewes scanned in each state does vary from 52% in Victoria to only 27% in Queensland (Table 19- round brackets). Out of the 15.87 million ewes scanned it can be seen (Table 19- square brackets) that one-third were scanned for wet-dry only (which represents 14% of the national breeding ewe flock), while the other two-thirds of the ewes pregnancy scanned were scanned for multiples (combination of those scanned for twins or triplets and foetal aging), which represents 26% of national breeding ewe flock (Table 19). However, the proportion of ewes scanned for multiples in each state does vary markedly; from three-quarters of the ewes scanned in Victoria (which represents 39% of the whole Victorian ewe flock) to less than half of the ewes scanned in Queensland (which represent only 12% of the whole Queensland ewe flock). The proportion of Western Australian ewes scanned for multiples was also below the national average at only 19% (Table 19).

With the exception of scanners interviewed in Western Australia and Queensland, the majority of scanners indicated that the proportion of ewes scanned for multiples was increasing relative to wet-dry scanning. Also the practices of scanning ewes for triplets and foetal aging multiple scanned ewes are starting to increase, which together now represent 10% of the ewes scanned nationally (Table 19). The greatest uptake of scanning for triplets and foetal aging multiple scanned ewes has been in Victoria and Tasmania, where in total those practices now represent 15% and 12% respectively of the ewes scanned in these states (Table 19).

The higher uptake of pregnancy practices related to managing multiples (either scanning for twins, triplets and/or foetal aging multiples) in Victoria and Tasmania could be a direct reflection of the higher proportion of non-Merino ewes in these states than other states that generally have higher fecundity rates. The uptake in part may also be attributable to some highly capable pregnancy scanners that are servicing and promoting best-practice scanning to Victorian and Tasmanian producers more than is occurring in other states. In addition, the success of program such as LTEM and BWBL in Victoria means that more producers are being educated in best-practice. For example, the penetration of LTEM among Victorian producers is higher than any other state.

Table 19. Summary of the pregnancy scanning conducted in Australia by state.

State	No. of ewes	Total ewes scanned	Ewes scanned wet-dry	Total ewes scanned multiples	Ewes scanned twin	Ewes scanned triplet	Ewes scanned multiple and foetal aged	Scanning businesses surveyed
Vic	**8.2m**	(52%) 4,280,000	(13%) 1,086,700 [25%]	(39%) 3,193,300 [75%]	(31%) 2,541,900 [59%]	(3%) 259,100 [6%]	(5%) 392,300 [9%]	21
SA	**5.8m**	(39%) 2,265,000	(15%) 894,000 [39%]	(24%) 1,371,000 [61%]	(21%) 1,190,900 [53%]	(1%) 70,100 [3%]	(2%) 110,000 [5%]	10
QLD	**1.3m**	(27%) 352,000	(15%) 199,100 [57%]	(12%) 152,900 [43%]	(11%) 139,200 [40%]	(0.2%) 2,500 [1%]	(1%) 11,200 [3%]	7
WA	**7.5m**	(32%) 2,406,000	(14%) 1,025,260 [43%]	(19%) 1,384,540 [57%]	(16%) 1,210,550 [50%]	(0.4%) 31,340 [1%]	(2%) 138,850 [6%]	14
NSW	**15.3m**	(39%) 6,005,000	(16%) 2,378,000 [40%]	(24%) 3,627,000 [60%]	(21%) 3,232,750 [54%]	(0.4%) 60,250 [1%]	(2%) 334,000 [6%]	36
Tas	**1.3m**	(43%) 560,000	(4%) 45,000 [8%]	(40%) 515,000 [92%]	(34%) 446,500 [80%]	(1%) 16,000 [3%]	(4%) 52,500 [9%]	4
Aus-Total	**39.4m**	(40%) 15,868,000	(14%) 5,628,060 [35%]	(26%) 10,239,940 [65%]	(22%) 8,761,800 [55%]	(1%) 439,290 [3%]	(3%) 1,038,850 [7%]	92

( ) denotes the percentage of the total number of ewes in each row (state or national).

[ ] denotes the percentage of the ewes scanned in each row (state or national).

The pregnancy scanning businesses were asked to outline the rates they charge for different tasks (Table 20). The tasks included; scanning to detect pregnancy (wet-dry), scanning for multiples (twins and triplets combined), scanning for triplets (identifying the number of twins and triplets), and scanning for multiples with foetal aging. The results highlight that the charge for wet-dry scanning across Australia is very consistent, with only a five cent range from $0.52 per ewe in Western Australia to $0.57 in South Australia (Table 20). The national average for wet-dry scanning was $0.54, while to scan for multiples the national average was $0.75 per ewe. The biggest price gap between scanning for wet-dry and multiples was in Western Australia at $0.24 and the lowest price gap was in Victoria at $0.19 per ewe (Table 20). Again the prices charged to undertake scanning for multiples were consistent across the country, with less than a 10% range in prices. The average price of scanning ewes for multiples and foetal aging as well, was $0.80 per ewe. While the cost of scanning ewes for triplets (ie. identifying the number of twins and triplets) were $0.82 per ewe.

Table 20. Summary of the cost of pregnancy scanning in Australia (by state) and willingness to push for multiple scanning over wet-dry and to grow their business.

State	Cost to scan wet-dry	Cost to scan for multiples	Cost to scan for triplets	Cost to scan for multiples and foetal age	Push to scan for multiples over wet-dry (out of 10)	Capacity to grow scanning business (out of 10)
Vic	$0.54	$0.73	$0.81	$0.78	5.2	3.6
SA	$0.57	$0.76	$0.79	$0.79	3.7	4.7
QLD	$0.52	$0.72	$0.75	$0.80	4.1	5.6
WA	$0.49	$0.73	$0.78	$0.78	4.2	4.5
NSW	$0.55	$0.77	$0.85	$0.85	3.9	3.6
Tas	$0.53	$0.78	$0.85	$0.85	6.0	6.3
Total	$0.54	$0.75	$0.82	$0.80	4.3	4.1

Pregnancy scanners were asked to rate out of ten how hard they push/promote scanning for multiples over scanning for wet-dry only, from 1 (where they just accept what the producer requests) to 10 (they push/promote hard for multiple scanning over wet-dry). The average rating was 4.3 out of 10 (Table 20), with Tasmania and Victoria clearly encouraging multiple scanning more than the other states, which corroborates with the fact these states have the highest proportion of ewes scanned for multiples (Table 19).

Scanners indicated that the common producer barriers for not scanning for multiples were a lack of paddocks, limited ability to manage singles and twins separately and too many twins in a mob at lambing causing miss-mothering. Very similar reasons for not pregnancy scanning for multiples were nominated by producers themselves surveyed in an earlier component of this project, in particular not enough paddocks available to manage singles and twins separately, a lack of labour available to undertake scanning, poor results in twin mobs in the past and questioning of the cost-benefit of pregnancy scanning for multiples. Although these barriers to adopting scanning for multiples seem illogical to both other producers and advisors that are committed to trying to improve reproduction rates and particularly lamb survival, they are representative of the context and beliefs of a large portion of Australia's sheep producers. In contrast sheep advisors extending the virtues of scanning for multiples and producers that have adopted the practice all recognise that a key outcome it provides is preparedness for managing ewes to their pregnancy status and the upcoming lambing. A selling point for scanning for multiples that producers rated highly as a motivator to adopt in the producer survey (Table 7) was the statement scanning for multiples 'saves time rather than creating more work'.

Pregnancy scanners were also asked to rate out of ten their capacity to grow their scanning business; from 1 (already at full capacity) to 10 (have capacity to grow their business significantly). The average rating was 4.1 out of 10 (Table 20), indicating a limited ability among the current scanners operating in Australia to scan more ewes.

In addition to querying if scanners recommended scanning for multiples over wet-dry scanning, the pregnancy scanners were asked in general if they provided sheep advice to their clients. Almost all scanners responded by saying they provide informal advice to clients on sheep husbandry, nutrition and management practices as part of their scanning service. Many recognised they don't have the knowledge or the qualifications to provide advice but where they did have some understanding, specific practices such as condition scoring or mob sizes for lambing, were recommended, along with regular discussions about lamb survival and marking rates.

Pregnancy scanners were specifically asked to estimate the average survival of lambs born in Australia by comparing multiple scanning rates (foetuses per 100 ewes joined) to lamb marking rates (lambs marked per 100 ewes joined). The average estimate of lamb survival by pregnancy scanners was 79% (Table 21), which is high when compared to industry estimates of lamb survival (Sentinel Flock Project 2009-12; National Reproduction Plan 2012) suggesting that survival rates are closer to 70%. For example, over the five years from 2010/11 to 2014/15, even with record marking rates (averaging 90%) the estimated lamb survival from the national flock which averaged about 125% at scanning was 72%. The lamb survival estimate of 84% given by scanners in South Australia and Western Australia appear to be particularly high and most unrealistic (Table 21).

When you consider that on average pregnancy scanners only know the lamb marking rate of 23% of their clients' properties (Table 21), it is understandable that their estimates of lamb survival from scanning to marking lack accuracy. When quizzed further less than half of the nations' pregnancy scanners could provide targets for marking rates from scanned single and scanned twin mobs, in either Merino or crossbred ewe flocks (Table 21). Pregnancy scanners interviewed in South Australia, and Western Australia had a particularly poor understanding of target marking rates from single and twin mobs, with only around one-third of them able to provide marking targets (Table 21) which corroborates with their over-estimate of national lamb survival rates, previously discussed.

Table 21. Pregnancy scanners estimate of national lamb survival rate, the percent of clients who they know marking rate, the percent who provided marking rate targets for singles and twins and the degree of care they have for improving clients' lamb survival.

State	Average estimate of lamb survival from scanning to marking (%)	Average percent (%) of clients for whom scanners know their lamb marking results	Percent (%) of scanners that provided marking targets for single and twin mobs	Degree of care for improving clients' lamb survival rates (out of 5)
Vic	78	22	62	4.2
SA	84	29	30	4.3
QLD	78	19	43	4.4
WA	84	27	36	4.3
NSW	75	19	47	4.2
Tas	79	33	75	4.3
Total	79	23	48	4.2

Despite having a limited understanding of national lamb survival rates, client marking rates and best-practice marking targets for single and twin mobs, pregnancy scanners care and interest in helping their clients to improve lamb survival rated consistently high. Scanners were asked to rate out of 5 (self-assessed) their degree of care, where 1 equated to 'little focus' and 5 'major focus'. The average 'care factor' from across the nations' scanners was 4.2 out of 5 (Table 21). The scanners then highlighted the key limitations to them helping their clients more with lamb survival and they were; a lack of time with clients, lack of knowledge and not qualified or insured to be an advisor.

Even though pregnancy scanners have a limited understanding of national lamb survival rates, client marking rates and best-practice marking targets for single and twin mobs and a lack of knowledge of how to improve lamb survival; they often provide informal advice to clients on sheep husbandry, nutrition, reproduction and management practices as part of their scanning service. The represents are great opportunity for industry (eg. MLA) to invest in upskilling scanners to improve the level of advice they are providing to producers and ensure that scanners provide more accurate best-practice lamb survival targets to producers.

During the interview with pregnancy scanners when estimated lamb loss (about 30% loss between scanning and marking) across the Australian sheep industry was revealed, unanimously all scanners interviewed regarded the loss as unacceptable for both the industry and their clients. Yet 93% of scanners did feel that the industry statistics were relevant to their clients, while acknowledging that some of their clients were performing well above average for lamb survival. More importantly 96% of the scanners interviewed agreed after hearing the industry statistics they were more motivated to work to improve lamb survival on their clients' farms. Finally, when asked how they felt about the data on industry lamb losses they 'wanted to do more with clients' and 'believed lamb loss could be decreased significantly'.

Scanners were then asked whether or not they recommended courses/information sources to their clients (Table 22). The programs/courses examined and the percent of scanners recommending them were;

- Lifetime Ewe Management - 76%,
- Bred Well Fed Well - 42%,
- Lamb Autopsy Workshops (different name in different states) - 16%, and
- AWI State Networks - 30%.

The relatively low recommendation rate of Bred Well Fed Well, Lamb Autopsy Workshops and AWI State Networks was predominantly due to a lack of awareness of these opportunities rather than perceived problems with the value of the content. This lack of awareness leading to a generally low recommendation rate was particularly evident in comments in relation to the Lamb Autopsy Workshops. Whereas more scanners had heard of Bred Well Fed Well but often stated they had been unable to attend because they were too busy to go themselves to assess the value for their clients.

Several scanners commented they need more understanding of the programs/workshop themselves to give them the confidence to sell to clients, which presents a great opportunity for the industry (eg. MLA) to invest in improving scanners' understanding. Particular interest was shown by the majority of scanners in the Lamb Autopsy Workshops to firstly improve their own understanding of lamb survival rates and causes of lamb loss to pass onto clients but to also organise these workshops for their clients directly, which would present an additional opportunity for scanners to have contact with their clients.

The referral of clients to the relevant AWI State Networks varied significantly from a low of only 6% of NSW scanners recommending Sheep Connect NSW, whereas over 70% of scanners in both Tasmania and Victoria recommend Sheep Connect Tasmania and Best Wool Best Lamb respectively (Table 22). This variation in recommendation rate was due to a combination of both awareness levels and lack of perceived value.

The only other program that a few scanners mentioned they recommend for their clients was the Managing Scanned Ewe Workshops run by the Sheep CRC. This is now named Managing Ewe Potential and is overseen by Achieve Ag Solutions in Victoria but very few have been run in recent years.

Table 22. Percent of pregnancy scanners in Australia that recommend LTEM, Bred Well Fed Well, Lamb Autopsy Workshops and AWI state networks to their clients.

State	Recommend Lifetime Ewe Management to clients (%)	Recommend Bred Well Fed Well to clients (%)	Recommend lamb autopsy workshops to clients (%)	Recommend state AWI network (%)
Vic	86	38	14	71
SA	80	30	20	20
QLD	67	50	0	50
WA	57	36	21	29
NSW	75	47	19	6
Tas	100	50	0	75
Total	76	42	16	30

The 92 pregnancy scanning businesses interviewed were asked to assess the capability of themselves and other scanners working for them (which totalled 140 practicing scanners) to undertake the following tasks (Table 23). The tasks included;

- scanning for twins (often referred to as scanning for multiples- twins and triplets combined),
- scanning for triplets (identifying the number of twins and triplets separately), and
- scanning for multiples with foetal aging.

It was found that overall 80% of scanners believed they were capable at scanning for twins (Table 23). However, the capability levels varied by state, with over 90% of scanners servicing Victoria and Tasmania being capable of twinning, whereas less than 60% of WA and QLD scanners could perform that task.

The variation in scanner capability by state aligns very well with the proportion of scanned ewes in each state that are scanned for twins (multiples). With three-quarters or more of ewes scanned in Victoria and Tasmania being scanned for multiples, whereas only about half of the ewes scanned in Western Australian and Queensland are scanned for multiples.

Less than half (43%) of all Australian scanners believed they were capable at scanning for triplets and just over half (55%) felt they could foetal age while scanning for multiples (Table 23). The slightly higher proportion of scanners being capable of foetal aging reflects the greater demand by producers for this (ie. scanners getting more practice at foetal aging) compared to scanning for triplets. Despite these current low levels of capability, many scanners demonstrated a genuine appetite for training to improve their skill level. Over half of the scanners had engaged in activities run by the Sheep CRC for pregnancy scanners (Table 23) but many indicated nothing similar was being currently run. When queried about the concept of accreditation for pregnancy scanners over two-thirds of them indicated they were willing to partake in and support an accreditation process for scanners. Given there has been some contention around accreditation for scanners, which is effectively unregulated; this demonstrates a fairly high commitment level among scanners for the concept. Scanner willingness to partake in and support an accreditation process for scanners was, firstly to improve their own scanning accuracy and secondly to sustain the standards of the wider scanning industry.

This represents a tremendous opportunity for industry to benchmark and improve scanning services offered to the wider sheep industry. Action needs to be taken immediately to upskill scanners, firstly as effective/accurate scanners and secondly providers of useful advice/direction to producers, otherwise mediocrity from pregnancy scanners on both fronts, as a key influencer of producers' reproductive management, will continue to limit best-practice adoption.

Table 23. Capability (self-assessed) of pregnancy scanners in Australia to scan for twins, triplets and foetal age and willingness to engage in scanner accreditation.

State	Capable of scanning for twins	Capable of scanning for triplets	Capable of scanning for foetus age	Previously engaged in CRC activities	Willing to partake in an accreditation process for scanners
Vic	92	43	57	62	76
SA	71	50	50	50	63
QLD	57	29	43	33	80
WA	59	41	41	21	62
NSW	87	40	60	58	65
Tas	100	80	80	75	75
Total	80	43	55	52	68

5.5 Consultants

Sheep consultants/advisors from Western Australia, South Australia, Victoria and New South Wales were interviewed in this study to examine the messages that are being extended to sheep producers relating to reproduction rates, in particular lamb survival. The sheep consultants/advisors targeted ranged from LTEM deliverers to protagonists against the value of reproduction rates in self-replacing flocks. The primary purpose of interviewing a range of consultants/advisors was to assess the degree of mixed messages to producers regarding sheep reproduction and lamb survival.

The mixed messaging from consultants/advisors was evident in the contrasting responses that were given to questions right from the beginning of the interview. When asked to identify the major priorities for sheep producers to improve productivity and profitability the suggestions put forward included;

- lifting stocking rates and increasing pasture utilisation,
- improving pasture density and productivity,
- genetics, and
- increasing the number of lambs weaned per hectare.

When specifically quizzed about the importance of reproduction rates in self-replacing flocks the responses were very mixed. The following remarks came from different consultants, all with contrasting advice to sheep producers;

- 'reproduction is a secondary issue - **80% is enough** in self-replacing Merino flocks',
- '**85% is the minimum** you should be aiming for, under 85% there are easy things you can do to lift marking rates,
- '**Most profitable is the combination of meat and wool**, and low reproduction rates reduce the returns from sheep sales, which can result in the self-fulfilling prophecy that wool is more important than meat, **marking percentage is only not important if you are not selling any sheep**',
- '**don't push for high reproduction rates, 90-95% is ideal**, at greater than 100% there is marginal gains because of decreases in lamb growth rates and ewe stocking rates'.

The difference in messages from consultants became even more distinct when asked to relay their core messages to producers about managing the ewes' condition score profile. For example;

- 'the **target condition score is 2.5 for optimum profit**, not condition score 3.0 as promoted in Lifetime Ewe Management,
- 'condition score profile is a non-issue if you are lambing in September/October,
- 'Manage ewes to deliver consistent repro-rates of 90-5%, while running an efficient system',
- 'proactive ewe management impacts on business profitability and mitigates risk by achieving the improvements possible through following LTEM condition score profile'.

Consultants were specifically asked to estimate the average survival of lambs born in Australia by comparing multiple scanning rates (foetuses per 100 ewes joined) to lamb marking rates (lambs marked per 100 ewes joined). The average estimate of lamb survival by consultants was 73%, which is reasonable when compared to industry data suggesting that survival rates are closer to 70%. However, the range among the answers provided varied widely from 65% to 85% lamb survival. This variation was further reinforced when consultants provided their target marking rates for Merino ewes scanned single and Merino ewes scanned for multiples. The range in target marking rates provided for Merino ewes bearing a single was 80 to 95%, while for Merino ewes bearing twin lambs it was 120 to 160%. Hence some consultants are advocating a 60% survival of Merino twins, while others promote 80% as the target.

During the interview with consultants when the estimated lamb loss (about 30% from scanning to marking) across the Australian sheep industry was revealed, half of the consultants interviewed regarded the loss as unacceptable for the industry and the other half felt it was acceptable. Yet all consultants felt that the industry statistics on lamb survival were relevant to their clients. However only half of them felt more motivated to help clients improve survival rates as a result of understanding the level of lamb loss across the industry.

When asked how they felt about the industry lamb survival rates, completely contrasting comments were made, such as;

- 'half of the loss that is occurring is retrievable'
- 'in 35 years in the industry, trying to change lamb survival rates and we've achieved nothing'
- 'it's a looming welfare issue, as well as a loss of profit',
- 'it pisses me off that industry is making a moral issue of something that is not profitable to address'
- 'I am worried about societal impacts, we must pay attention to it',
- '70-year-old data, it's not a new issue, and it can't be addressed cost effectively.

This difference among consultants was further reinforced when they had to rate how much they cared about improving clients lamb survival. Consultants were asked to rate out of 5 their degree of care for improving client lamb survival, where 1 equated to 'little focus' and 5 'major focus'. The average 'care factor' recorded from across the consultants was 3.3 out of 5, and scores varied from as low as 1 to as high as 5. With the explanation from those with a low care factor saying 'improving lamb survival will not increase profit' and those with a high care factors saying 'improving lamb survival drives my client's profits'.

Where there was some agreeance from consultants was in what they regarded as the barriers to producers improving survival. With 75% of consultants indicating the biggest barrier was producers having never measured their lamb survival rates- so they don't know where they are at. Half agreed that not having enough paddocks to split ewes up was a barrier, particularly in mixed farms. However, of concern 38% of consultants felt that the barrier to producers improving lamb survival was 'it is hard work and not worth the effort'.

Consultants were asked to rate the impact of different selling points of scanning for multiples on the producer adoption of this practice regardless of whether the producers were not currently scanning or was currently scanning for wet-dry. The results are outline in Table 24.

Table 24. Consultant ratings of the impact of different selling points on producer adoption of scanning for multiples.

Selling point for the adoption of multiple scanning	Average rating out of 5 (1= low impact, 5= high impact)
Proof it improves efficiency and profitability	**4.3**
Evidence it helps improve lamb survival	4.0
Information on the cost-benefit of scanning	**3.6**
Saves time rather than creating more work	3.1
More cost effective use of supplements	**3.0**
It is worthwhile even with limited paddocks	2.7
Knowing how many lambs are dying	**2.6**

Finally, consultants were asked if they would recommend the following programs to their clients. It was found that;

- 100% of consultants interviewed recommended Lifetime Ewe Management,
- 63% of consultants interviewed recommended Bred Well Fed Well,
- 75% of consultants interviewed recommended Lamb Autopsy Workshops,
- 50% of consultants interviewed recommended their states AWI State Network.

5.6 Ram Breeders

Seed-stock producers (ram breeders) play an important role in either encouraging or discouraging uptake of technologies in the sheep industry. This role was assessed in this project through facilitated interviews with stud breeders. Forty ram breeders from South Australia, Victoria and New South Wales representing 26 Merinos, 7 Maternal and 7 Terminal flocks were interviewed. When asked if they thought their own lamb survival outcomes or those of the industry were acceptable, all except one participant strongly believed improvements were necessary in both.

When asked if they thought they had a role to play in improving industry lamb survival 100% of survey participants agreed that they did. The two strongest themes in the role they thought they could play were in education and genetics provided to the industry. The breeders generally thought they could play a role in demonstrating best practice management and nutrition as well as educating clients on these principles. In the genetics they supply to industry ram breeders generally thought they could/should supply genotypes that allowed higher lamb survival. To achieve this outcome, ram breeders noted providing rams with better fat and muscle as well as higher number of lambs weaned breeding values.

When asked about their breeding objective nearly 80% of merino ram breeders had increasing wool weight as part of that objective, whereas only one-third of them mentioned a trait related to reproduction. Interestingly wool quality also was mentioned by one-third of stud masters. This trend was confirmed when participants were asked about the relative weightings they apply to wool, reproduction, carcass, growth and easy care traits. The average weighting for selection for wool was 37% among merino ram breeders whereas the average weighting of selection for reproduction was only 18%. This figure was a little higher in maternal ram breeding enterprises at 24% but still somewhat lower than expected. Only 30% of merino ram breeders mentioned fertility when asked what their clients were interested in.

The ability of merino ram breeders to contribute good reproductive information to industry- is hampered by the level of recording done on most ram breeding flocks. Only 16% of merino ram breeders interviewed collected maternal pedigree on all sheep and a further 38% collected maternal pedigree on more than half of their lambs. However, 31% of ram breeders collected maternal pedigree on less than half of their lambs and 15% didn't collect it all. In the non-merino breeds, the large majority (92%) of ram breeders collected full pedigree with a small proportion (8%) collecting it on most but not all of their lambs. The most common reason provided by merino ram breeders for not collecting maternal pedigree was described as time, with money listed as an associated reason, as well as causing miss-mothering if tagging lambs at birth. These same reasons were the major reasons that ram breeders did not provide a number of lambs weaned breeding value on the rams sold.

Even in circumstances where maternal pedigree was collected this information was generally not used in a way that would allow effective decision making around finding genotypes with higher lamb survival. Of the merino breeders that completed the survey only 4% were getting the data in a format necessary to have NLW generated. In the non-merino breeders this number was ten times higher at 40%. The breeders were also generally not using the reproduction data they were collecting. Very few of the studs interviewed used birth type or rear type when visually classing animals. With few exceptions, the stud breeders commented that their stud sheep were run under better nutrition than their commercial sheep. This was considerably greater in the young rams being fed for sale.

5.7 Common issues across all segments consulted

The major problem with desire to improve lamb survival rates in particular and adoption of best practice required to improve survival rates, is a complete lack of awareness across the industry of the true level of lamb loss. Given that national scanning rates across all ewe types averages about 125% foetuses to ewes joined and marking rates for the last five years have averaged 88% (varying from a record high of 92% to a low of 85%) that equates to only 70% of the foetuses on board at scanning being alive at lamb marking, with the vast majority of loss occurring at birth or within the first 2-3 days post-birth. This question was posed to a range of segments of the sheep industry throughout this project and the results are summarised in the table below (Table 25).

Table 25. Estimate of Australian lamb survival rates by different segments of the industry.

Industry segment	Estimate of lamb survival (% that survive from scanning to marking)	Range in estimate of lamb survival
Producers not scanning for multiples	86	75-95
Stud breeders	85	75-95
Producers that scan for multiples	80	65-95
Pregnancy scanners	79	75-84
Sheep consultants	73	65-85
Australian average survival and likely range	70	50-90

The results in Table 25 show that all producer segments surveyed in this project over- estimate the lamb survival rates, at ≥ 80% survival compared to an actual industry average of 70%. Similarly, pregnancy scanners, who of all the influencers of sheep producers are directly engaged to help the issue of reproduction rates, also over-estimate the level of lamb survival. The only segment with a more accurate understanding of lamb survival rates were the sheep consultants. This general lack of awareness of the true levels of lamb loss is a critical issue because building awareness, understanding and discontent in relation to any issue are widely recognised as critical precursors for attitude and behavioral change, without which lamb loss will continue to be an insidious issue for the industry.

6 Pilot programs

This section reports of the three main pilot activities undertaken in this project. They include;

- Lambs Alive- supported learning package for producers,
- Scanning demonstration- demonstrating the benefits of scanning for multiples, and
- Pregnancy scanner capacity building- targeting engagement and development of scanners.

6.1 Lambs Alive

Lambs Alive (LA) is a supported learning package that coaches producers in the principles and practices that improve lamb survival in a whole-farm context. The following outlines the background to LA, the pilot program, including the goals and structure, within and post-course evaluation findings.

6.1.1 Background to Lambs Alive

Prior to reporting on the LA pilot program and its outcomes, below is a brief outline to provide context on why LA was developed, in particular its' purpose in contrast to LTEM. First, as part of objective 1 in this project, which examined the barriers for producers to adopt best-practice in reproduction and related welfare outcome, it was found that even those producers who were scanning for multiples across their flock still faced significant barriers to improving lamb survival. The barriers to improving lamb survival identified by those producers scanning for multiples were;

- lack of feed available at lambing,
- my farm has bad weather at lambing,
- not enough paddocks to split up ewes for lambing,
- lack of labour available, and
- not sure how to improve lamb survival further.

The common theme across these barriers is the challenge with allocating resources (feed, shelter, paddocks, labour and fencing) on a whole-farm basis to improve lamb survival. To optimize resource allocation on a farm to improve lamb survival involves a complex set decisions and requires skills in feed budgeting, condition scoring, paddock appraisal and allocation, planning for supplementary feed requirements, pasture management and manipulation. It was felt to build producer competence in these areas would require a highly effective and targeted supported learning activity. Given that some, but certainly not all, of these aspects were once covered in the second year of LTEM, which is no longer delivered with LTEM now only being a one-year course, a significant gap exists in the learning continuum for producers to improve lamb survival outcomes on a whole-farm basis. LTEM is effective for building the foundation skills of producers in condition scoring and energy budgeting, with a focus on managing one mob of ewes to LTEM guidelines. However, an additional education package is need to enable producers to improve resource allocation across their farm and flock to lift lamb survival. Targeting producers that have already adopted scanning for multiples but need assistance to reap the full benefits in lamb survival is a wise investment given their willingness to adopt best practice, quicker gains and minimize dis-adoption. LA can accommodate producers that join the program without having completed LTEM by running a bridging session on core skills such as condition scoring, pasture assessment and energy budgeting.

Subsequently the LA program was designed to give producers the knowledge and skills to better manage lambing with the primary aim of improving lamb survival by optimizing whole-farm resource

allocation between pregnancy scanning and lambing and then onto lamb marking. This required specific attention to management between total flock scanning and lamb marking, with a major focus on preparing the ewes and their lambing paddocks to enable better ewe type to paddock allocation for lambing. The LA program was designed to deliver to groups of producers (around 10 businesses) on a demonstration farm so that participants could follow the best management practice in a practical hands-on way. A combination of group workshop sessions with practical activities and 'one-on-one' coaching was deemed to be the best mix of delivery methods. Good record keeping by producers underpins the success of the program for both participating producers and funders.

6.1.2 Lambs Alive Pilot Program

Overview

Lambs Alive was designed to give producers the knowledge and skills to better manage lambing with the primary aim of improving lamb survival by optimising whole farm resource allocation. This required specific attention to management between total flock scanning and lamb marking, with a major focus given to preparing the ewes and their lambing paddocks to enable better paddock allocation for lambing. The program was delivered on demonstration farms so participants could follow the best management practice in a practical hands-on way. The combination of 'One-on-One' coaching and workshop sessions was deemed to be the best mix of delivery methodologies. Good record keeping was required to underpin the success of the program.

Primary Goals

- To improve whole-flock lamb survival,
- Producers learn best practice management for lambing,
- Prepare ewes and their lambing paddocks during late-pregnancy to allow better allocation at the point of lambing, and
- Increase the kilograms of wool and/or lamb produced per hectare.

Secondary Goals

- To ensure that ewes have optimum pre and post lambing nutrition,
- Producers have adequate recording systems to make good decisions, and
- That ewe wastage is kept to a minimum.

Underpinning methodologies for learning

- Learning was built around the action learning model of review, plan, act and monitor,
- Each participant developed a detailed lambing plan and followed it through,
- Where possible the KIS principle was used,
- Discussion was fostered on the key issues,
- Learning was built around a representative demonstration farm, and
- Good sound lambing records were encouraged to be kept to allow for a sound review.

Lambs Alive Development Team

Development workshops have been held in Ballarat on January 20, March 8th and April 15TH 2016. Each of the meetings allowed Project Developer Ken Solly to progress the development of the Lambs Alive Program in between.

The Development team comprised:

- Jason Trompf – Sheep Consultant, JT Agri-source Wangaratta, Victoria.
- Andrew Thompson – Senior Consultant Murdoch University (1st meeting only) Murdoch WA.
- Tim Leeming – Specialist Sheep producer Harrow Victoria
- Ken Solly – Agribusiness Consultant & Lambs Alive Project Developer, Naracoorte SA.
- Lyndon Kubeil – Manager Best Wool Best Lamb Benalla. Victoria (3rd meeting only)

Lambs Alive - Structure and Timetable of Delivery

The program was designed around four activities, 3 workshop sessions held on the Demonstration Farm and a one on one coaching session on each of the participant's properties.

Activity 1 – Setting up for and Managing Lambing.

Activity 2 - Individual "One on One" On Farm Lambing Coaching Sessions

Activity 3 - Monitoring and Fine Tuning Individual Lambing Plans

Activity 4 - Reviewing your Lambing Success

The development team agreed to the following structure and delivery of the program.

Lambs Alive - Structure and Timetable of Delivery			
Timeframe – **Days Pre and Post Lambing**	**Days**	**Activity**	**Comments**
Day - 60 to -80	0	**Scanning**	Ensure group has a reasonably tight lambing i.e. lamb at same time
Day -30 to -50	20	**Setting up for and Managing Lambing.** - 7 Hour Workshop	Cover all the fundamentals of Best Management Practice
Day - 30 to - 50	50	**Individual "One on One" On Farm Lambing Coaching Sessions** - Half Day Session	Half Day 1 on 1 consultancy. Completed for last lamber @ -30 days
DAY -5 to + 20	70	**Monitoring and Fine Tuning Individual Lambing Plans** - 6 Hour Session	Half Day -Flexing the plan to suit the season, ensure all bases are covered. Lamb Autopsy work undertaken.
Day 100 to 120 Weaning	180	**Review your Lambing** Success - 6 Hour Session	Analyse the data and gain ideas for further improvement. What worked and what did not work.

Actual Delivery Timetable Summary 2016

All sessions were delivered jointly by each of the Group Facilitators and Project Developer Ken Solly with strong input from the demonstration farm manager in each case. Helen McGregor Veterinarian/Consultant with Achieve Ag co delivered the Western Plains group in conjunction with Ken Solly. Helen's animal health and autopsy work was a strong point. Helen is also a registered business coach who also bought extra skills and knowledge to the program.

	Lambs Alive – Potential in Product - Actual Delivery Timetable Summary 2016			
Group Name	Pigeon Ponds South West Vic	Western Plains Western District Vic	Barwon Western Vic	Greta North East Vic
Group Facilitator	Tim Leeming	Ken Solly	Nathan Scott	Jason Trompf
Demonstration Farm	Tim Leeming Pigeon Ponds	Amanda Manifold Camperdown	Will Hansen Colac	Hannah Marriott Greta
Farms Participating	9	11	10	8
No Participants	12	12	12	10
Session One **Planning for Lambing**	Completed 23/5/2016	Completed 1/06/2016	Completed 3/06/2016	Completed 18/5/2016
Session 2 **On farm Coaching**	Completed 29/07/2016	Completed 15/09/2016	Completed 26/08/2016	Completed 01/08/2016
Session 3 **Fine Tuning the lambing Plan**	Completed 4/07/2016	Completed 12/07/2016	Completed 29/07/2016	Completed 28/06/2016
Session 4 **Reviewing the Success of Lambing**	Completed 20/9/2016	Completed 11/10/2016	Completed 14/10/2016	In complete

Logic behind the program structure

Key Elements for the workshop	Rationale behind key elements
Activity 1	**Setting up for and Managing Lambing**
1. Audit Workshop Attendees Lambing System – (Collected upon arrival)	• Gain an understanding of the sheep production systems that you are working with so deliverer can use examples in context. Clickers could be used here.
2. Analysis of Livestock Farm Monitor Project results	• Establish the reality of what is being achieved and could be achieved • Where LFMP is not applicable deliver needs to have examples of what each production system is using in each region
3. Understanding the profit drivers in Wool & Lamb Production and the role reproduction plays	• Use the profit driver model to represent the mainstream production system of each group
4. Managing Ewes - Scanning to Weaning, 50 days before and 50 days after lambing	• Slide presentation walking producers through all the important consideration for the 100 day period
5. Lambing –Focusing on the Lambing Critical Success Factors	• Principles that under pin LTEM. Participants complete Lamb Loss and Ewe Wastage calculator and Body Condition Scoring exercise.
6. Animal Health Programs prior to and during Lambing	• Short presentation on Animal Health Issues that must be addressed. Address both vaccination and drenching
7. Feed budgeting during Lambing	• Using simple spreadsheet model to teach feed budgeting • Ensure producers do a manual calculation for one mob and paddock aided by Feed Budget tables. • Do briefing of paddock exercise that will be undertaken immediately after lunch
8. Lambing Paddock Planning for the Case Study Farm –	• Applying the learning. Using the blank spreadsheet model, head to the paddock and allocate mobs to paddocks using what has been previously learned.
9. Record Keeping during Lambing & Lambing review – (Handouts)	• Understand the importance of keeping good records to review lambing and identify areas of improvement next time.
10. Summary, questions, discussion and evaluation	• Ensure a brief summary of the six pack for success and gain feedback on the workshop
11. Workshop Close	• Need something social following so deliverers can mingle and sense the mood and value of the workshop.

Activity 2	**Individual "One on One" On Farm Lambing Coaching Session**
12. Consultant working one on one with the producer on property	• To ensure all participants have a documented lambing plan and are upskilled in areas of weakness • Briefing on lambing program • Ranking your lambing paddocks • Splitting or aggregating mobs • Countering cause of past losses • Establish FOO levels in each paddock • Confirm CS of ewes • Pasture Budgets and Stocking rates • Allocating mobs to paddocks • Supplementary feeding during lambing • Set targets and timing • Anticipated other management issues during lambing • Finalize the Lambing Plan • Strategies and tactics to implement during lambing
Activity 3	**Monitoring and Fine Tuning the Lambing Plan**
13. Fine Tuning the lambing Plan taking into account recent changes to conditions	• Revisit pasture allocations and feed budget • Tour of Demonstration farm lambing paddocks to work through planning principles.
14. Lamb Post Mortem's during lambing	• Short presentation on identifying causes of lamb deaths. Provide a template for lamb death recordings. Demonstrate post mortem technique and identify cause of death. Provide text Lambs Alive
15. Lambing Marking & Weaning	• Work through programs of best management practice
16. Summary, questions, discussion and evaluation	• Ensure a brief summary of the six pack for success and gain feedback on the workshop
Activity 4	**Reviewing your Lambing Success**
17. Presentation of Individual Lambing Data	• Identify individual issues that impacted on lambing success
18. Presentation of Group Data	• Groups trends, identify issues that underpinned the best results
19. Review of key strategies and tactics	• What worked what did not? What can we learn from each other
20. Review the management used on the demonstration farm	• Inspect property, ewes lambs and pasture to see the outcome of the management used on the demo farm
21. Resetting the plan for the next years lambing	• Participants to complete an action plan
22. Review and evaluation of the Lambs Alive program	• Did Lambs Alive impact on your lambing success and what improvements need to be made to make the program better.

Important Understandings

In the case of the Pigeon Ponds and Western Plains Lambs Alive groups they experienced a much more challenging lambing weather wise; they experienced 6 extreme wind chill events during lambing as opposed to 1 and 2 in the previous couple of lambing years. Initially the program sought each producer to set targets for their twin and single survival percentages for the 2016 lambing. Following 2 relatively kind lambing seasons in 2014 and 2015 the targets were possibly ambitious and given their lack of performance recall beyond last year's lambing it would appear that estimations were turned into guesses very quickly. Guessing is not tolerated in this program so it was deemed better to determine performance outcomes relative to the set of circumstances in a given year. It should be noted that running a program such as Lambs Alive just prior to lambing was correctly timed, but some of the issues that impact lamb survival are much more long term. The full benefits of the Lambs Alive program will be realized by participants next year and in the years thereafter.

Main Tools, Texts and Resources used in the delivery of Lambs alive

Tools, Texts and Reference	Purpose or Use
MS Excel File: Lamb Loss and Ewe Wastage Calculator	To determine the likely number of lambs lost during lambing and calculate the combined ewe deaths, ewes dry and ewes that do not rear a lamb. A tool developed by Ken Solly for use with his clients.
Large White Cardboard Broadsheet	To record base data on participants flocks
MS Word File: Analysing Performance –Setting Targets	To collate the past 3 years of lambing performance in all key performance indicator areas
MS Word File: Paddock Selection Criteria	A planning tool to do all the Lambing Paddock Allocations
MS Excel File: Copy of Feed budget	A feed budgeting tool developed by Ken Solly for use with his clients.
Lambs Alive Text: A hands on Approach to optimising Lamb Survival	AWI and MLA text used to aid the correct cause of lamb deaths with useful aid of photos
MS Word File: LA Final Record Sheet	Used to record dead lamb cause of death
MS Word File: LA – Review Questions	Used for participants to review the Lambs Alive performance.
MS Excel: LA Lambing Data	Spreadsheet to record group lambing data
PDF File: Lambing Paddock Records	Paddock Recording also used in Lambing Density
MS Word File: Lambs Alive Final Evaluation	Sheet used in evaluating Lambs Alive Program

Other Documents and Tools used:

- Lambs Alive Coaching Guidelines – MS Word
- Lambs Alive Coaching Questions – MS Word
- Lambs Alive Coaching Report – MS Word
- Lambs Alive Coaching Timetables – MS Word
- Sheep Benchmarks per Hectare – MS Excel
- Lambs Alive Budget 2 – Funding Source April 2016
- Wind chill for the Hamilton Research Station
- Step by Step guide to the use of the Lamb Los & Ewe Wastage Calculator

The majority of these documents were developed for Lambs Alive or contributed by Ken Solly. Several other documents were developed for consideration and were not used but may have future application.

Power Point Presentations

Each of activity 1, 2 & 4 were supported with Power Point Presentation. These were"

- Lambs Alive – Potential into Product – Setting up and preparing for Lambing.
- Lambs Alive Cobbitty Jul 16 –Refining your Lambing Plan
- Barwon - Review You Lambing Success – Review your Lambing Success.

All these presentations need reviewing and updating on an ongoing basis.

Files provided on USB stick

12 Excel spreadsheets were provided on a memory stick with the Lambs Alive manual at the commencement of the program. Many of these spreadsheets were used in the delivery of the program others were useful additions to the topics covered.

Demonstration Farms are invaluable for learning

The Demonstration farms proved invaluable in the Lambs Alive program for the following reasons:

- They allowed for hands on learning
- Allowed participants to be involved in developing a lambing plan first hand before going home to develop their own.
- Gained practical reinforcement of pasture assessment and feed budgeting
- Observed lambing best management practice
- Gained better buy in to new ideas and concepts
- Instigated better and more focused questions
- Gave a much needed differing methodology for learning
- Provide an opportunity to follow another producers lambing from start to finish
- Taught the importance of being objective in everything being done
- Allowed better group learning, dealing with real subject matter

Coaching Sessions achieve good outcomes

Following the first Session "Setting up for and Managing Lambing" the participants returned home with a framework to complete their own Lambing Plan. The Coaching sessions allowed for the following:

- A skilled consultants eyes to be cast over the plan
- Review less obvious reasons for the decisions made on lambing plans
- Do a representative tour of farm to check off the decisions made behind the paddock selections
- Check that pasture assessments, feed budgets and stocking rates were correct
- Anticipate likely lambing issues and how best to manage them
- Deal with questions that participants may not have felt comfortable asking in a larger group
- Ensure that the Lambing Plan was the best possible and make adjustments if needed
- Ensure that the record keeping requirements were well understood

The Lambs Alive participants valued highly the opportunity to work 'One-on-One' with a coach.

2016 Lambs Alive Group Lambing Results

Lambs Alive Group Reproductive Performance					
Group	Total Ewes	Total Foetuses	Lambs Marked	Foetus/Lms Lost	Survival %
Pigeon Ponds	35336	51804	42653	9151	82.3%
Western Plains	34651	51128	40085	11043	78.4%
Barwon	33986	47349	37421	9928	79%
Greta	22170	33010	25352	7658	77%
Total	126,143	183,291	145,511	37,780	79.4%
Percentages		145.3%	115.4%	20.6%	79.4%

Flock/Mob numbers by Breed						
Group	Merino	1st X	Composite	Coopworth	Highlander	Total
Pigeon Ponds	4		7			11
Western Plains	4	2	8	1		15
Barwon	5	3	7		1	16
Greta	6	1	3			10
Total	19	6	25	1	1	52

It is believed that an extra 10% to 15% of ewes are under the same management of the producers involved in the Lambs Alive program. A small number of producers did not submit all their ewes into the Lambs Alive program and many ewe lambs having their first lamb are not represented either. The 80% overall survival in the 2016 Lambs Alive program compares favourably with that of previous years where the lambing conditions were much more favourable. Whilst unable to claim so the Delivery team would like to think that the Lambs Alive program may have allowed 5% additional foetuses to be turned into live lambs. 5% of the 180,000 foetuses is an additional 9,000 live lambs. It should also be noted that slaughter numbers and regional saleyards lamb sales are down this season which may reflect the difficult lambing season but it is too early to draw conclusions.

Appendices 1-4 in Milestone Report 8 are the collated lambing results of each of the 4 Lambs Alive Pilot Groups. It should be noted that several attempts were made to gather the missing data and in the end it was decided to not waste any more time doing so. A few may have felt uncomfortable sharing a lower than desired lambing result. To be able to populate the data set estimated lamb marking percentages have been used for 6 of the total of 52 flocks involved.

To discuss the results on a group basis or to compare groups would not be a fair comparison. With different ewe breeds, sires, time of lambing and lambing criteria, undertaking a comparison may lead to the wrong conclusions. Many days of time would be required to set up and undertake a correct analysis.

Whilst the majority of Lambs Alive participants were Lifetime Ewe Management graduates and deemed to be above average producers there is still remains great scope for improved lamb survival

Genetics was not a focus in Lambs Alive but still needs to be a consideration and contributing factor to the lambing results.

Major Strategies pursued by producers in Lambs Alive in 2016

Following the completion of the Lamb Loss and Ewe Wastage exercise the participants were required to allocate the anticipated dead lamb numbers to a cause of death. The major causes of anticipated lamb loss were starvation, mismothering and dystocia. The major strategies pursued in Lambs Alive to counter the loss were:

- Better planning to get feed ahead of the twin bearing ewes
- Differentially managing ewes on a pregnancy status basis
- Ensuring single bearing ewes were not overfed in the last third of pregnancy
- Due consideration was given to pasture, paddock size, protection, privacy, predation and past performance of the lambing paddocks when allocating to twins or singles
- Better lambing records were kept on which to make future decisions
- Better skills were gained in diagnosing cause of lamb deaths
- Increased pasture growth was gained with the use of urea and gibberellic acid
- Developing and overall measure to manage approach
- Gain better knowledge and skills to set up good lambing plans
- Use of electric fencing to sub-divide more paddocks for lambing to enable reduce mob sizes
- Hold ewes in containment longer, closer to lambing time to build more FOO in lambing paddocks

Main On-Farm changes that will be implemented by producers for the 2017 lambing

At the end of the Lambs Alive Program each member of each group was asked to identify at least one area of management they would definitely change for the 2017 lambing and these are as follows;

Pigeon Ponds Lambs Alive Group – Changes for 2017 Lambing

- Smaller Lambing Paddocks (several)
- Increase Lamb birthweight
- Split Joining
- Improve late pregnancy nutrition
- No more than 800 kg DM/ha FOO for singles
- Develop trigger points for singles
- Select lower birthweight rams
- Scan for single/twin and feed accordingly
- Get feed wedge ahead of the ewes
- Increase birthweight ram ASBV
- Reduce lambing mob size to below 100 ewes for twins
- Reduce paddock size and ewe density
- Improve privacy
- Split paddocks for lambing
- Scan for early and late pregnancy
- Manage triplet ewes better

Western Plains Lambs Alive group – Changes for 2017 Lambing

- Smaller lambing Paddocks
- Flush Ewes
- Use vasectomised rams
- Focus on Calcium and Selenium deficiency
- Improve condition score at Joining
- Shorten lambing length
- Bring lambing forward 2 weeks
- Plant more trees
- Get more feed ahead of the lambing ewes
- Set stock over lambing
- Squeeze up the singles to create more opportunity for the twins
- Develop run off paddocks for lambing
- Maintain Condition Score targets
- Improve shelter
- Reduce paddock size and mob size
- Grow more grass and manage it better
- Improve the flexibility in the lambing system
- Improve paddock planning and management

Barwon Lambs Alive Group – Changes for 2017 Lambing

- Improve Condition Score at joining
- Later lambing by 2 weeks
- Condition Score of 3.3 for twin ewes at lambing
- Split ewes on CS at lambing
- Increase FOO levels at lambing
- Flush ewes
- Retain the Lambs Alive program for 2017
- Have ewe CS at 3.5 at the end of spring
- Vaccinate a month before lambing

Greta Lambs Alive Group – Changes for 2017 Lambing

- More sub-division of the farm for lambing using both permanent and electric fencing
- Build more containment pens to hold more ewes in well drained pens closer to lambing
- Manage ewes from scanning to lambing so twins lamb in 0.5 condition score more than singles
- Smaller mob sizes for twins
- Vaccinate for Campylobacter to reduce abortion rates of lambs

Unintended benefits of Lambs Alive Program

From the Western Plains Lambs Alive group, the largest flock represented is managed by Nathan Hahn at Mortlake. Nathan believes he is lambing at the right time but is always frustrated by his inability to get feed ahead of his ewes. With the assistance of Ken Solly, Nathan undertook a week long study tour of New Zealand to study his topic of frustration. His findings will be shared back with the Western Plains Lambs Alive Group

Another Western Plains Lambs Alive member Tim Gubbins a Nuffield Scholar worked with Nathan Hahn on the genetics of their large flocks. They were unknown to each other prior to Lambs Alive.

Through the development of the Lambs Alive program there is now a body of information and materials now available for better extension work to be done in this area. The Delivery team in itself is now better equipped to service the sheep industry in terms of lambing extension.

The general sharing of ideas and thirst for knowledge was extremely high in all Pilot groups. The sheer fact of getting these individuals into groups has seen enormous sharing of knowledge and ideas.

Helen McGregor demonstrates the correct procedure for determining the cause of death in new born lambs to the Western Plains Lambs Alive Group in the "Fine Tuning the Lambing Plan session" It was a brute of a day so the protection of the Milangil woolshed was much appreciated.

Lambs Alive Evaluation

At the conclusions of the Lambs Alive Program the participants completed a 9 question evaluation and ranked the Lambs Alive Program according to the quality of delivery, content of the program and the impact on their farm.

Pigeon Ponds Lambs Alive - Program Evaluation Rankings (Leeming/Solly) **10 Highest – 1 Lowest**											
	1	2	3	4	5	6	7	8	9	10	Ave
Quality of Delivery								3	1	6	9.3
Quality of Content								3	5	2	8.9
Impact on your Farm							1	2	5	2	8.8
10 Respondents											

Western Plains Lambs Alive - Program Evaluation Rankings (Solly/McGregor)

10 Highest – 1 Lowest											
	1	2	3	4	5	6	7	8	9	10	Ave
Quality of Delivery								2	2	4	9.2
Quality of Content								3	1	4	9.1
Impact on your Farm						1	1	2		4	8.6
8 Respondents											

Barwon Lambs Alive - Program Evaluation Rankings (Scott/Solly) **10 Highest – 1 Lowest**											
	1	2	3	4	5	6	7	8	9	10	Ave
Quality of Delivery								1	4	3	9.2
Quality of Content								2	3	3	9.1
Impact on your Farm							2	1	2	3	8.7
8 Respondents											

Lambs Alive Combined Group Rankings	**Ave Ranking**
Quality of Delivery	9.2
Quality of Content	9
Impact on your Farm	8.7

Keeping in mind that the majority of the participants in Lambs Alive were graduates of Lifetime Ewe Management is was pleasing that the rankings for this program were high. With delivery ranking the highest it would appear that the ability to engage and get the message across of the training staff was very good. Content of the program also ranked highly which was always going to be a challenge given the LTEM background.

Impact on farm whilst the lowest of the rankings it still gained a very sound score. The individuals that scored impact lowest were either high achievers already or the season had not allowed them to gain the results to command a higher impact score. It should be noted that the ranking differences between the groups was not significant either.

Lambs Alive Program Review

Following the completion of all groups a review of the Pilot program was conducted in Ballarat on November 17th.

This review was attended by the entire Lambs Alive Pilot Program Delivery Team.

- Jason Trompf – Sheep Consultant, JT Agrisource, Wangaratta, Victoria.
- Tim Leeming – Specialist Sheep producer, Harrow, Victoria
- Ken Solly – Agribusiness Consultant & Lambs Alive Project Developer, Naracoorte SA.
- Nathan Scott – Special Sheep Consultant, Inverleigh, Victoria.
- Helen McGregor – Veterinarian/Consultant/Coach, Newport Victoria

Recommendations for Improvement of the Lambs Alive program

Structure of the program

The 4 activity structure and timelines on the Lambs Alive program are deemed to be correct and should be maintained in any future delivery. The demonstration farms, one on one coaching sessions and workshop components were considered to be very sound elements of delivery leading to the success of the program.

The Development team are extremely happy with the title and by line given to the title of the Lambs Alive program. They are exactly what the program is trying to achieve.

Suggested Improvements to the Lambs Alive program

At the Development team review the following recommendations were made. These were made on the back of the feedback given by the participants.

- Clear goals need to be articulated at the start of each session.
- Pre- requisite to the Lambs Alive program is that participants need to have completed Lifetime Ewe management, scan for multiple pregnancy and be prepared to differentially manage ewes
- Preference to have a tight lambing group (no more than 6 weeks), all around the same time. This is deemed essential for comparison of data and for the analysis to be undertaken.
- The goal of the program should be to increase lamb survival by 5% in the first instance
- Continue the reinforce Condition scoring and Energy Budgeting
- Condition Score of both Twin and Single bearing ewes at lambing must be known.
- Need to streamline the recording elements to reduce the burden and make things simpler
- The background data kept by participants prior to Lambs Alive was found to be minimal so there is a need for a basic process to capture this information for use in Lambs Alive
- Avoid computer work in the session – should be a take home activity.
- Autopsy session needs to be earlier than or as early as possible.
- Provision of Lamb Live weight kit to be made available at the commencement of the course.
- Include triplets in the Lamb Loss and Ewe Wastage Calculator
- Leave ewe lambs out of the data recording
- Look at redesigning the Lamb Loss and Ewe Waste Calculator to be more user friendly.

- To change the wording on the Lamb Loss and Ewe Wastage calculator from Cause of Loss to Contributing Factors to death.
- Move from predictor to actual for last year so they are working on facts
- The use of vertical headings on the Paddock Planner to save space and colour code selected sections of the sheet for ease of reading eg Bred Well Fed Well broadsheet.
- The coaching report needs simplification and reducing to one page.
- Include a strong section on Wind Chill Factor in the folder.
- Have an Apple MAC version of the Lamb Loss and Ewe Wastage calculator
- Ensure that data is for ewes only; some of the data includes lambing performance of ewe lambs. Despite briefing the groups well, data was still presented as whole farm.

Gaining better baseline data and information

Participants in the Lambs Alive Pilot Program were provided with a Data Questionnaire "Analysing Performance – Setting Targets which was to be filled in a bought to the first session. It was apparent that very few had the detailed data required from the last three years of lambing. It was decided to simplify this requirement to as follows:

Record last year's performance:

- Mature Ewes Joined
- Joining Date
- Scanning %
- Foetuses Scanned
- Twin Scan %
- Single Scan %
- Lambs Weaned
- Single Marking %
- Twin Marking %
- Lambs Survival %
- % dry ewes
- % dead ewes

Plus, bring 4 questions that you want answers to from this lambing.

Participants are then required to insert this information into the Lamb Loss and Ewe Wastage calculator. They then work from the known to the predicted for the coming year.

Lambs Alive -Testimonials/Media Potential

The Pilot Program Delivery team consider the following participants in the Pilot Lambs Alive program to have a great deal to offer in terms of being very good advocates for the LA program.

Gordon Brown – Barwon Group

Tim Gubbins - Western Plains Group

Will Hansen – Barwon Group

Richard Edgar – Pigeon Ponds Group

Nathan Hahn – Western Plains Group

Nick Harvey – Pigeon Ponds Group

Andrew Edgar – Pigeon Ponds Group

Tony Noble – Barwon Group

Deane and Henry Goode – Pigeon Ponds Group

Hannah Marriot – Greta Group

Potential Trainers for Lambs Alive

The Pilot Program Delivery team consider the success of Lambs Alive is strongly linked to quality of the Trainers delivering the program. Trainers should only be considered for LA if they have;

- A high level of knowledge of sheep reproduction and management
- Have a demonstrated ability to deliver high quality training and extension.
- Meet timelines and administrative requirements in a timely manner
- Are highly respected in this field of expertise
- Demonstrate a high level of professionalism in everything they do

With these key points in mind the following consultant were listed as potential trainers for LA;

- Tim Leeming – Victoria
- Nathan Scott – Victoria
- Helen McGregor – Victoria
- Andrew Whale – Victoria
- Jason Trompf – Victoria
- Ken Solly – South Australia/Victoria
- Lisa Warn – Victoria
- Hamish Dickson – South Australia
- Geoff Duddy – New South Wales/Queensland
- Ashley Herbert – Western Australia
- Paul Omedei –Western Australia

The above list is by no means exhaustive and needs to be added to particularly outside of Victoria.

Budgeting for Future Lambs Alive Delivery

The Lambs Alive Development team recommends that future delivery of the program be done at $1500 per day with up to $100 per producer/participant additional to cover travel for the coaching sessions. A recruitment fee of $1,000 per group which will include gaining the demonstration farm

This $1500 daily fee will cover:

- Planning and preparation for each session

- Travel time and cost to each workshop (Extra payment for coaching sessions)
- Delivery of the workshop session
- Collect and Collate data for the group on an ongoing basis
- Organise catering
- Administer the groups training program
- Provide teaching equipment for sessions

Lambs Alive Proposed Budget 2017 – Group of 10 Producers			
	Unit cost	No Units	$
Recruit Group and Set Up Demo Farm	1000	1	1000
Trainer - Preparation, Delivery & Group Management	1500	3	4500
Lambs Alive Manuals, plus LA Postmortem Booklet	100	10	1000
Coaching Sessions	750	10	7500
Travel Coaching Sessions	100	10	1000
Collecting, Collating & Reporting Data end of program	1000	1	1000
Total Cost per group of 10 producers			16,000

It must be noted that there is no costing for reimbursement to the Demonstration farmer and a cost recovery of the administration of the program.

Lambs Alive feedback – Recorded and summarised from the Barwon Group

The following dot points were recorded on a small audio recorder at the conclusion of the Barwon Group by Nathan Scott;

- Forced them to keep more records which was a great outcome
- Autopsy day was excellent
- Reinforcing the LTEM concepts, and forced them to focus on it more again
- 2 participants developed their own autopsy sheet which was simpler
- Autopsy info would be good to get well before lambing (use autumn lambs)
- Also cover autopsy of own lambs again in the next session while lambing
- Ewe Wastage spreadsheet was simplified by a couple of producers, but were otherwise good
- Some of the spreadsheets were too hard to follow. Simplifying the process would be good.
- Would like there to be a second year to follow up and have another go next lambing.
- Big advantage being the host property
- Simple spreadsheets would be used more broadly
- Need to include triplets in all spreadsheets
- Group feels it would be very difficult if it was a standalone program, and the last session was the last opportunity to meet as a group.

- Pricing - LTEM provides a base for value proposition. $800-$1000 was the general feeling, but is in hindsight. $150k worth of lost lambs for one member makes it easy for him to justify.
- Could be done over 4 days + consultancy. Needs to allow more time, and folder to be more methodical so that it is easy to follow, and more structured progression.
- Number of days was fine for one participant was fine, just streamline it a bit more

USB Stick – List what is on it, and how it is to be used. "Print this off and bring to session 2" etc.

All participants have room for improvement still, so follow up critical

Folder was limited in its usefulness, in some ways because of the way different people learn. One participant doesn't look at the folder in between sessions, only learning during sessions.

Group didn't think there would be any issues in sharing their results with people they didn't know, compared to what they experienced in the pilot where they already knew everyone (this is a biased group however – they are very good at sharing!)

Even if results achieved aren't good, it gives you a base point to start from.

Summary of Lambs Alive Pilot

Despite many of the LAMBS Alive participants having overseen 20 to 30 lambing's the program still challenged all the participants. For most it was the first time they had been exposed or experienced a thorough and detailed planning approach to lambing.

The Development team are very confident that the Lambs Alive Program approach will continue to be used by these producers for lambing in the coming years. Many of the producers are keen to go through the same process again next year.

The Development team believe that Lambs Alive is 5% increase in survival in the first year, some more some maybe less. If this is the case, then 50 lambs saved per 1000 ewes could represent a $15,000 to $20,000 saving on the average farm in Lambs Alive. Added to this is less ewe deaths and more surplus sheep sales. Whilst increasing the number of lambs conceived is still worth pursuing, keeping more of the existing foetuses alive should still remain a high priority.

The Development team strongly believe in the power of the Lambs Alive program and are very keen to see the program fine-tuned and rolled out across Australia. The potential of Lambs Alive to deliver more live lambs is one thing but to also address the animal welfare aspect of lamb survival is equally as important. Before Lambs Alive is to be rolled out across the country a thorough post-course evaluation of the pilot program is to be undertaken, to quantify the impacts of LA and inform continuous improvement.

6.1.3 Post-course evaluation of the Lambs Alive Pilot Program

Objective 5 of this project was to evaluate key pilot activities and provide data on the changes in knowledge, attitude, skills and aspirations (KASA) of participating producers in relation to the adoption of industry best practice. The evaluation framework used to report on LA is using Bennett's Hierarchy, which summarises the program from inputs through to end results. The questions used to evaluate the LA program are attached as Appendix I of this document.

Outlined below is a summary of the evaluation of the LA program aligned with the Bennett's Hierarchy framework. The cost estimates (in the 'inputs' section) reflect what the costs are likely to be for delivery of a LA group once the package is finalized without the additional costs that were incurred to develop the program (structure and content) and oversee the pilot program.

Inputs

The cost estimate of delivering a LA group, without program development or administration costs is outlined in the table below (Table 26).

Table 26. Proposed budget to deliver Lambs Alive to a group of 10 farm businesses.

Lambs Alive activity/item to be costed	Unit cost ($)	No. of units	$
Recruitment of group and identify demonstration farm	1000	1	1000
Lambs Alive Manuals, plus LA Postmortem Booklet	100	10	1000
Trainer - preparation, travel, delivery, group management	1500	3	4500
Delivery of one-on-one coaching sessions	750	10	7500
Travel to individual properties for coaching sessions	100	10	1000
Collecting, collating & reporting data end of program	1000	1	1000
Total cost per group of 10 producers			16,000

It should be noted that the estimated costing does include the cost of printing a manual for the program, plus each participant requires a copy of the Lambs Alive Postmortem Booklet.

The cost per business to participate in LA (assuming a group of 10 businesses) based on these cost estimates would be $1600. If LA was to be delivered in accordance with the new Profitable Grazing Systems (PGS) extension program that means producers would contribute $1000 per business and the balance of $600 could be claimed through PGS.

Activities

The LA program was designed around four activities, which includes three group workshop sessions held on a demonstration farm and a one-on-one coaching session on each participant's property. The four activities were;

- Activity 1- setting up and managing lambing,
- Activity 2- individual one-on-one coaching (on farm) for lambing,
- Activity 3- monitoring and fine-tuning property lambing plans, and

- Activity 4- review your lambing success.

The full program structure, logic and learning outcomes have been reported in the previous section.

Participation

During the pilot phase of LA four groups were established. The group locations and delivers were;

- Pigeon Ponds- Tim Leeming,
- Western Plains- Ken Solly,
- Barwon- Nathan Scott, and
- Greta- Jason Trompf.

In total the pilot groups involved 38 farm businesses, comprising of 46 participants. The outcomes from LA reported in the remaining sections of this framework were based on feedback from participants in the Pigeon Ponds, Western Plains and Barwon groups, which had a total of 30 businesses, of which 20 (67%) were surveyed as part of this evaluation. The evaluation was designed and conducted by Jason Trompf and targeted the groups he had no involvement with. As part of the evaluation the following background farm details were collected on participants (Table 27), that related to both before (2015) and after (2016) LA.

Table 27. Lambs Alive participant farm characteristics before and after the program.

Characteristic	Before Lambs Alive (2015)	After Lambs Alive (2016)
Total farm size (ha)	1356	1366
Area winter cropped (ha)	176	169
Area for winter grazing (ha)	1160	1177
Weather conditions for lambing (poor/average/good)	95% rated good (very mild conditions)	95% rated poor (extreme wet, high chill)
Number of Merino ewes	27,620	29,558
Number of non-Merino ewes	48,330	55,727
Average number of ewes per farm involved	3,798	4,264

The data in Table 27 shows that the participants in LA were of a significant scale (3,798 ewes) and growing to even bigger sheep enterprises by the completion of the program (4,264 ewes). It should be noted that the weather conditions for lambing during the LA program were rated as poor by 95% of participants compared to 95% rating the conditions in 2015 as good, which will be discussed further in the end results section of this evaluation.

Reactions

From the 20 LA participants surveyed the average overall satisfaction score for the program was 8.5 out of 10 (Table 28). The ratings ranged from 8 to 10, with the exception of one rating of 7 out of 10, and one rating of 6 out of 10. Pilot participants were also asked to rate the program for delivery,

content and impact on their farm, the results of which are shown in Table 28. The ratings for both delivery and content were very high. The rating for the impact on participants' farms was a little lower but still impressive at 7.5 out 10 (Table 28). The issue that tempered the impact on farm for pilot participants was the terrible weather conditions during lambing that limited gains in lamb marking rates, and will be discussed further in the end results section of this evaluation.

Table 28. Reactions of pilot participants to the Lambs Alive program.

Measure of the program	Rating out of 10
Overall satisfaction rating of the Lambs Alive program	8.5/10
Rating of the standard of delivery of Lambs Alive program	8.9/10
Rating of the standard of content of Lambs Alive program	8.3/10
Rating of the standard of impact of your farm of Lambs Alive	7.5/10
Recommend Lambs Alive to other producers	100%
Price willing to pay for Lambs Alive	$742

Two further measures of producer reactions to the LA program are whether they would recommend it to other producers and what they would be willing to pay to participate in the program if offered commercially. It was found that 100% of LA participants had already recommended the program to other producers and that on reflection they would be willing to pay an average of $742 to participate (Table 28). The amount producers nominated that they would be willing to pay ranged from $300 to $1200, with the majority nominating $700 to $1000.

Participants were asked to suggest how LA could be improved. The suggestions included;

- spread-sheets and data recording need to be simplified and better laid out,
- creating a lambing diary that participants could complete throughout lambing,
- the material assembled for the program needed more structure and to flow better, and
- more information on managing triplet bearing ewes and triplet lamb survival.

LA participants were also asked if the program was worth doing on top of LTEM and 95% indicated it was. Also 60% of LA participants felt producers could do LA without having done LTEM. The key issues identified with producers not having completed LTEM first were difficulty understanding the language, ability to assess pasture, condition score and energy budget. There were a few examples of this in the pilot and they all got good value out of LA but a bridging session would help upskilling.

Changes in KASA

The skill level of the producers changed significantly due to their participation in LA (Table 29), particularly in skills areas that were unique to LA in contrast to others skills previously improved in programs like LTEM. For instance, participation in LA increased their ability to assess pastures, condition score ewes, calculate their metabolisable energy balance, manage ewes to achieve condition score targets and make precise supplementary feeding decisions all by about 0.5 units on

the 1 to 5 skill rating scale (Table 29). Whereas for skills such as understanding the primary causes of lamb loss and how to rectify them, differential management of ewes based on pregnancy status so that twins lamb in at least a third of condition score higher than singles, ability to plan resources needed from scanning to lamb marking and paddock allocation at lambing, the improvement as a result of LA was closer to 1.5 units on the 1 to 5 skill rating scale (Table 29). The whole farm and flock focus of LA compared to a focus on one mob in LTEM has really developed producer's knowledge and skills to better manage lambing by optimizing whole-farm resources allocation between pregnancy scanning and lambing and onto lamb marking across the flock, which is exactly what LA was designed to achieved. These skills areas that LA participants had the most development in align with the areas of most significant practice change in the next section.

Table 29. The skill level ratings (out of 5) for undertaking specific management skills, as perceived by Lambs Alive participants pre and post their involvement in the program.

Skill areas	Skill level pre LA (2015)	Skill level post LA (2016)
Estimating pasture quantity- feed on offer and quality- digestibility	3.5	4.0
Manipulating pasture production to achieve pasture targets	3.0	3.8
Accurately condition score ewes	3.8	4.2
Calculate and correct ewe's metabolisable energy (ME) balance	3.3	3.8
Managing ewes to achieve target condition scores at key times	3.4	4.0
Making precise supplementary feeding decisions based on knowledge of feed supply, feed demand and ewe condition score	3.3	4.0
Differential management of ewes based on preg. status and/or CS so that twins lamb at least 0.3 condition score higher than singles	2.8	4.0
Paddock allocation at lambing- assess pasture, protection, privacy and past performance to inform allocation of twins and singles	2.5	4.1
Ability to plan resources needed for the whole flock from scanning to weaning & optimise whole farm resource allocation across flock	2.7	4.1
Identify/understand primary causes of lamb loss and how to rectify	2.6	4.1

Practice change

Almost all (95%) LA participants changed practice as a result of the program. When asked to list the key practice changes made as a result of LA the practices nominated and the percentage of participants who nominated that practice change were;

- more paddock sub-division for lambing- 60%,
- smaller mobs of twins for lambing- 40%,
- improved paddock allocation for lambing- 40%,
- using temporary fencing for sub-division for lambing- 40%,
- shifted time of lambing later by 2 to 4 weeks- 25%,
- increased feed-on-offer at lambing by using Urea and/or stock containment- 25%,
- running singles harder between scanning and lambing- 20%,

- feed budgeting to hit pasture targets for lambing- 20%, and
- fetal-aging at pregnancy scanning- 15%.

In addition to the open-ended question on practice changes, LA participants were asked to declare which of the practices listed in (Table 30) were part of their normal farm management pre and post involvement in the LA program. The most significant changes in the proportion of LA participants registered were for practices such as; more targeted paddock allocation at lambing, keeping accurate lambing records by mob and paddock, reallocating feed away from singles to twins so that twins lamb at least a third of a condition score higher than singles and sub-dividing more paddocks to enable smaller mobs for lambing. There was also almost a doubling in the percentage of LA participant's autumn saving pastures to build a feed wedge, differentially managing singles and twins, and lambing twins in much smaller mobs and smaller mobs than singles (Table 30).

Table 30. The proportion of Lambs Alive participants using specific pasture and sheep management practices prior to and after participating in Lambs Alive.

Management practice	Prior to LA (2015)	Post LA (2016)
Autumn saving/deferred grazing of pasture to build feed wedge	50	95
Use growth promotants (eg. Urea) to increase FOO for lambing	30	55
Assess pasture quantity/quality to achieve key pasture targets	75	100
Condition scoring of ewes at weaning to prepare for joining and scanning to prepare for lambing	80	100
Draft ewes into different mobs based on condition score and manage separate	75	100
Manage ewes to achieve condition score targets at key times such as joining and lambing	85	95
Scanning ewes for pregnancy status – dry, single and multiples	85	95
Scanning ewes for multiples and foetal age (ie. early and late)	15	37
Differentially manage single and multiple bearing ewes from immediately post scanning to lambing and to weaning	50	95
Calculate Metabolisible Energy (ME) balance (requirement versus intake) then adjust paddock and/or rations accordingly	85	95
Reallocate feed (supplement and pasture) away from singles to twins so that twins lamb at least 0.3 CS higher than singles	25	95
Assess pasture, paddock size, protection, privacy, predation & past performance to inform paddock allocation- twins v singles	15	95
Sub divide more paddocks (with either permanent or temporary fencing) to enable more smaller mobs for lambing	30	100
Lamb twins in smaller mobs and much small mobs than singles	55	95
Keep accurate lambing records by mob and paddock and use information to inform future paddock allocation for lambing	20	100
Joining length of 5 weeks or less	60	80
Quantify lamb survival rates across your whole farm and for all enterprises- by comparing scanning to marking %	75	95
Quantify breeding ewe wastage across flock each year- that is the percentage that die, are scanned dry or don't rear a lamb	10	60
Wet-dry ewes at marking/weaning (feel udders, draft off dries)	55	85

End result

An outcome of the increase in paddock sub-division among LA participants is an increase in the number of paddocks for lambing, which is allowing producers to decrease the average mob size of twin bearing ewes for lambing and subsequently improve the marking rates in twin mobs (Table 31). The intention of LA participants for the same parameters by 2018 was also recorded (Table 31).

Table 31. The number of lambing paddocks, average mob size and marking rates for single and twin bearing ewes among participants prior to and after LA and intentions by 2018.

	Prior to LA (2015)	Post LA (2016)	Intended (2018)
Number of lambing paddocks for main lambing	25	31	40
Average mob size for lambing twin bearing ewes	150	109	88
Average marking % in twin mobs (main enterprise)	150	153	-
Average mob size for lambing single bearing ewes	262	250	242
Average marking % in single mobs (main enterprise)	90	88	-

By 2018 LA participants intend to have increased their number of lambing paddocks by 60% (from 25 to 40 paddocks) and decreased the mob size of twins at lambing by 41% (from 150 to 88 in a mob). Interestingly LA participants intend to maintain similar numbers of single bearing ewes in a paddock for lambing over-time (Table 31).

A feature of the LA program is the records being kept by participants on the reproductive performance of their ewe flocks. Table 32 summarizes the performance of Merino ewes managed by LA participants' pre and post participating in the program. It can be seen that the scanning percentage of Merino ewes in 2016 was 5% lower than in 2015, which it should be noted couldn't be influenced by LA because the program commenced post scanning in 2016 for most flocks. Despite this lower scanning rates lamb marking rates from Merino ewes were maintained (96%) due to a 3% improvement in lamb survival rates (Table 32).

This is an outstanding result given that almost all participants rated the lambing conditions in 2016 as 'poor' compared to 'good' in 2015. The 2016 lambing for most LA participants was extremely wet, in some cases floods, and high chill conditions. This observation is vindicated when you consider national lamb marking rates dropped from 92% in 2015 to just 85% in 2016 (data provide by Ben Thomas from the MLA/AWI survey). Hence the real impact of LA on Merino marking rates is more like +7% when weighted to accounted for the seasonal differences between 2015 and 2016.

Table 32. The performance of Merino ewes in flocks managed by Lambs Alive participants pre and post their involvement in the program.

Performance measure	Prior to LA (2015)	Post LA (2016)
Number of Merino ewes joined (to either Merino or non-Merinos)	27,620	29,558
Number of foetuses scanned	36,056	37,288
Average scanning percentage (total foetuses to total ewes joined)	131%	126%
Number of lambs marked	26,475	28,268
Average marking percentage (lamb marked to total ewes joined)	96%	96%
Average lamb survival from scanning to lambing for Merino ewes	73%	76%

Table 33 summarizes the performance of non-Merino ewes managed by LA participants' pre and post participating in the program. It can be seen that the scanning percentage of non-Merino ewes

in 2016 was 2% lower than in 2015, yet despite this lamb marking rates from non-Merino ewes were maintained (127%) due to a slight improvement in lamb survival rates (Table 33). This is again an outstanding given that almost all participants rated the lambing conditions in 2016 as 'poor' compared to 'good' in 2015.

Table 33. The performance of non-Merino ewes in flocks managed by Lambs Alive participants pre and post their involvement in the program.

Performance measure	Prior to LA (2015)	Post LA (2016)
Number of non-Merino ewes joined	48,330	55,727
Number of foetuses scanned	74,740	85,451
Average scanning percentage (total foetuses to total ewes joined)	155%	153%
Number of lambs marked	61,576	70,532
Average marking percentage (lamb marked to total ewes joined)	127%	127%
Average lamb survival from scanning to lambing for non- Merinos	82%	83%

Overall, despite national lamb marking percentages dropping by 7% between 2015 and 2016, LA participants were able to maintain marking rates year on year. Hence when adjusted for seasonal impacts the real gains in marking rate by LA participants would be in the order of 7%. Certainly the changes in skills and practice among LA participants means they are well equipment to deliver solid gains in marking rates with a return to normal lambing conditions or if poor lambing conditions occur again they have the resilience and capability to sustain marking rates.

An additional outcome of participation in LA has been a 5% improvement in whole-farm stocking rates between 2015 and 2016, from 10.8 to 11.3 DSE/ha. Furthermore 60% of LA participants intend to increase stocking rates in future as a result of LA, with the average increase in stocking rate intended by 2018 of 9.2%. The changes in practice nominated by LA participants that are enabling them to increase stocking rates and the percentage of participants nominating them are;

- shifting time of lambing 2 to 4 weeks later- 25% of participants,
- smaller paddocks due to sub-division allowing better pasture utilisation- 20% of participants,
- running singles harder between pregnancy scanning and lambing- 20% of participants, and
- autumn saving pastures and using Urea and/or Pro Gibb to lift growth- 20% of participants.

6.2 Scanning demonstrations

The scanning demonstrations involved pregnancy scanning ewes for multiples on currently non-adopting farms to demonstrated the benefits of managing single and twin bearing ewes separately. Producers that followed their consultants' recommendations not to adopt scanning were targeted, to curb the consultants influence on producers and show what can actually be achieved.

6.2.1 Background to scanning demonstrations

Surveying undertaken by Mandy Curnow (DAFWA) on behalf of the Sheep CRC estimates that only 25% of sheep producer's pregnancy scan for multiples (CRC National Producer Survey, 2014). This estimate has been validated by the surveying of pregnancy scanners nationally in this project, that found 26% of ewes in Australia are scanned for multiples. A contributing factor to the low adoption of multiple scanning, particularly among merino producers, is the continued recommendation from prominent sheep consultants that it does not pay to scan for multiples and differentially manage ewes based on pregnancy status and that pursuing merino marking rates above 80% is not profitable.

It should be noted that the lack of uptake of scanning for multiples is not just unique to Merino producers in fact the CRC survey indicates exactly the same proportion of producers (25%) with non-Merino compared to those with Merino ewes or dual purpose flocks scan for multiples.

Two case studies were undertaken in the pilot phase, both with Merino self-replacing enterprises that join some ewes to terminals. One case study demonstrated the value of multiple scanning to a non-scanning producer and the other demonstrated the value of multiple scanning to a producer that currently only scans ewes for wet-dry occasionally. Both producers have been influenced/advised by prominent sheep consultants not to adopt the practice of pregnancy scanning for multiples. The questions used to evaluate the two case studies are attached as Appendix II.

6.2.2 Scanning demonstrations pilot program and evaluation of effectiveness

Neil Harris Case Study- demonstrating the value of multiple scanning to a non-scanner

Background- Neil Harris from Mangalore was engaged as part of the pilot as a producer who did not pregnancy scan at all prior to the pilot. The Harris enterprise consists of 2,500 Merino ewes joined to Merino rams and 1,500 Merino ewes mated to Poll Dorset. The average wool production is 6 kg/ewe of 17.5 micron wool and the enterprise is July lambing.

Neil's focus has been on wool cut per ha and pasture production to drive numbers and kg's per ha, under the advice of consultants that told him 80% of lambs is enough out of Merinos and instead concentrate on wool cut per ha. The typical marking rate of Neil's flock is 90% lambs marked to ewes joined for Merinos mated to Merinos and 100% for Merinos mated to Poll Dorset. Neil's typical scanning practice was to not scan at all, saying "I didn't think it was economic to scan".

As part of the pilot 660 adult ewes were scanned for multiples. The adult ewes scanned 150% (foetuses/ewes joined) comprising of 42 dry ewes, 253 single bearing ewes and 365 twin bearing ewes. The scanning cost was 85 cents/ewe, which totalled $560 for the Harris pilot. In addition, both Jason Trompf and Lyndon Kubeil visited Neil on three occasions to assess ewe condition score

and provide guidance on the scanning outcome and how Neil could best manage the ewes from scanning to lambing.

When asked for Neil's first thoughts about the scanning results of 150% (foetuses/ewes joined) he said, "it is mind blowing, when you consider on average we have been losing 60 lambs per 100 ewes between scanning and marking". "Clearly you can't manage what you don't measure and I wasn't measuring it, so I couldn't manage it".

The overall lamb marking result achieved was 762 lambs out of the 660 ewes joined, which represents a marking rate of 116%. This comprised of mob based marking results, including;

- 247 lambs from 153 single bearing ewes, which represents a marking rate of 97%,
- 198 lambs from 132 twin bearing ewes, which represents a marking rate of 150%,
- 319 lambs from 227 twin bearing ewes, which represents a marking rate of 141%.

Neil had a number of key learnings from the process, including;

- "I was aiming for 170% marking rate from my twins but I realise from talking with Jason that first time at it this is a good result and the ewes and lambs look great",
- "In future I have got to be prepared to have the twins separate and provide supplement if necessary to have the twins in good condition score and smaller mobs at lambing if possible",
- "it is well worth the cost of scanning when you compare it to the value of extra lambs",
- "120% of lambs gives me options, in future I am going to focus more on increasing numbers through improving marking percentage, which gives more flexibility to sell more old sheep", and finally
- "the consultants saying that 80% of lambs out of Merino ewes is enough, I don't agree with it now, we can get 120% plus".

It should be noted that without the support provided to Neil and subsequent discussions about his lamb marking result from twins, Neil may have dis-adopted scanning for multiples because he felt 150% marking from scanned twin ewes was a bad result. This represents a twin lamb survival rate of 75% for Merino to Merino lambs which is markedly higher than the Victorian state average of 50-55% Merino twin survival.

Following the adult ewe pilot, Neil went on and scanned his later joined one-year-old Merino ewes, which he had tried joining for the first time. The one-year-old ewes scanned 118% (fetuses/100 ewes joined) comprising of 40 dry ewes, 199 single bearing ewes and 101 twin bearing ewes.

This pilot is very interesting when you consider Neil's starting point/attitude towards pregnancy scanning. Effectively lifting his marking rate from 90% to 116% means he has marked an extra 168 lambs (above his average) out of 660 ewes. If you value the extra lambs at $52/lamb (figure from John Young's modelling for the value of an extra Merino lamb after the cost of production at $5/kg carcase weight), this equates to almost $9,000 extra in profit (168 lambs x $52/lamb =$8,736) or $13.24 extra profit per ewe (which also aligns well with recent modelling undertaken by John Young).

James Teahan Case Study- promoting the value of multiple scanning to a wet-dry scanner

James Teahan runs large self-replacing Merino and cattle enterprises on 2,800 hectares near Mansfield. The sheep numbers include;

- 5,000 fine wool Merino ewes mated to Merinos,
- 2,000 fine wool Merino ewes mated to terminals, and
- 3-6,000 Merino wethers, depending on seasonal conditions.

James's focus is more on the wool component of his sheep enterprise, trying to run high stocking rates and lift wool cut per hectare, and turns off any lambs as stores. James's typical scanning practice is to scan all the maidens for wet-dry only and he also scans any 3-year-old ewes that were dry as maidens and his oldest age group of ewes but again just for wet-dry only. Hence the core of his mixed age ewes (3-5 years old) is typically not scanned at all. In this case study James scanned 2,000 of his Merino ewes that were joined to Merinos for multiples. The age groups he elected to scan for multiples were the maidens (2 years old), 3 year olds and 5 year olds.

The basis to James's current scanning practices was to always pregnancy test the maidens to get rid of those not in lamb and look after those that are pregnant. Then he would manually wet and dry the maidens at lamb marking and only keep those that have reared lambs. James's comment when asked about multiple scanning and advice he has received was, "I am well aware of the debate about the value of scanning for twins and have been listening to it and the advice we have received is that fertility is not a critical in a Merino flock".

The approach taken in this case study was effectively to provide James with a voucher to scan the ewes he would typically scan wet-dry to scan them for multiples instead. The voucher covered the $0.20 price gap between scanning for wet-dry only compared to the cost of scanning for multiples. No follow up support was provided to James either at the point of scanning or afterwards. The idea of this case study was to test the concept of a scanning voucher without any additional support.

The scanning results James quoted were for the following age groups;

- 3-year-old ewes that reared lambs as maidens- 118% (foetuses to ewes joined),
- 3-year-old ewes that didn't rear lambs as maidens- 139% (foetuses to ewes joined), and
- 5-year-old ewes joined to Merinos- 134% (foetuses to ewes joined).

Overall the feedback from James on the process of scanning for multiples and the lamb marking results he achieved was not very positive. He stated "we scanned 2,000 ewes for multiples and separated the singles and twins for lambing and we achieved the same lamb marking percentage as the ewes we didn't scan". After pressing James for more detail the following was gleaned;

- we normally mark 110% out of our 5-year-old ewes, and after scanning 134% we marked 115% of lambs, which is 5% above average, however the un-scanned 5-year-old last year marked 114% of lambs (also above average), so there was no difference in marking rate between the scanned and un-scanned ewes,
- the average mob size of ewes for lambing was 250 ewes, with most mobs between 200 to 300 ewes, with the odd smaller mob of twins.

Interestingly it appears that there was a strong relationship between the number of twin bearing ewes in a mob and twin lamb survival (Table 34). However, prior to collecting this data from James,

he had given little thought to that outcome and the fact that if he had lambed more of the twins in smaller mobs than his usual mob size of 250, he may have improved marking rates significantly.

When asked about the management of ewes following scanning, James responded by saying "had I been a better manager of the twin then maybe we would have got better results but for the time and effort it is not worth it". Also when asked about the marking results achieved following scanning James said "we didn't gain any more lambs and it was a pain in the arse finding paddocks for them, we put the twins on better feed on the flats and then we had feet troubles".

Table 34. The range in twin mob sizes at lambing and twin marking results at James Teahan's

Number of twin bearing ewes in a mob	Number of twin lambs marked	Marking percentage in twin mobs (%)
260	320	123
232	284	122
200	268	134
108	154	143
78	110	141
65	91	140
45	65	145

The marking results in Table 34 show that for mobs of 200 twins or more the average marking rate was 126%, whereas in the mobs of 108 or less the average marking rate was 142% (a 16% difference). This outcome is consistent with the findings of the survey conducted by BestWool/ BestLamb (BWBL) in 2014 on the impact of twin mob size at lambing on lamb survival that found survival decreases by 0.6% per extra lamb born per day.

The calculations in Table 35 show that applying this relationship to a comparison of the larger twin mobs (averaging 230 ewes) at James Teahan's, to his smaller twin mobs (averaging 74 ewes) this would result in a 16.6% increase in marking rate.

Table 35. Predicted difference in marking rates in large versus small twin mobs at James Teahan's

	Average size of larger twin mobs at James Teahan's	Average size of smaller twin mobs at James Teahan's
Mob size of twin bearing ewes	230	74
Number of foetuses in mob	460	148
Lambs born per day (assuming 75% born over 17 days)	20.3	6.5
Difference in lambs born per day	13.8	
Difference in twin lamb mortality (assuming 0.6% decrease in survival per extra lamb born per day)	8.3	
Difference in twin lamb marking rate for 156 ewes less in a mob	16.6%	

Once this was explained to James his response was, "the cost of sub-division in our hill country is too expensive, so limited scope and we have got limited resources because there is always other sheep to compete with ewes such as wethers and weaners".

James's final comment about trail scanning and lambing twins separately was "I can't see any benefit in it, maybe there would have been if I had of managed the twins better, but there is no economic benefit the way we run our farm".

Difference between the two case studies

The fundamental difference between the two case studies was the support provided to Neil Harris compared to James Teahan throughout the scanning to lambing process. The key learning from this work is that any future initiatives that aim to demonstrate benefits of scanning for multiples and differentially managing twins and singles in both pregnancy and for lambing, is that oversight and support is needed for the case study farms. In James Teahan's case, much better results would have been achieved if the twin bearing ewes were differentially managed post scanning and allocated to smaller mobs for lambing. Without this guidance, James has made the conclusion that there is no economic benefit for his operation. Conversely by providing more guidance Neil Harris achieved outstanding results and has completely changed his attitude and practice is relation to scanning ewes for multiples and managing twin bearers to improve lamb survival and lift whole-farm marking rates.

6.3 Pregnancy scanner capacity building "Scanning for the future pilot'

The Scanning for the Future Pilot involved engaging and survey pregnancy scanners and producers to understand the impact pregnancy scanning capacity and capability impacted on adoption of scanning for multiples by producers. The activities completed in this pilot project included;

1. Survey and engage scanners and producers
2. Formation of a working group including key personnel from 3 states
3. 1 day workshop and discussion forum with working group
4. Scoping of existing comparable training/models in vocational sector
5. Benchmarking for expected scanner accuracy

6. Logistics and scoping for accreditation/training days – scanner engagement and identification of sites, facilities and content

These activities were initially conducted to better understand the uptake of scanning by producers and to scope opportunities to support ongoing training and skill development in the scanning sector. Surveying identified that one of the greatest barriers to adoption is the availability of experienced and skilled scanners. On this basis, the pilot investigated the logistics and likelihood of adoption by scanners of a process of accreditation and training for increasing accuracy and repeatability.

6.3.1 Background to the pregnancy scanner capacity activities

Producer surveys

As part of the consultation process a survey 153 sheep producers from across 5 states was conducted. The location of the properties surveyed is shown in the Figure 7 below. The surveying was conducted at 3 major producer conferences in Victoria and NSW. Given the attendees at these events are there because they have a high level of interest in improving their enterprise, this represents a bias cross section of sheep producers in Australia. It is expected that the proportion of producers represented in the 'not-utilising scanning' cohort would be much larger if taken across all sheep producers. These producers provided feedback to a series of questions determining the use of scanning as a management tool and how it was impacting decisions for ewe management at lambing.

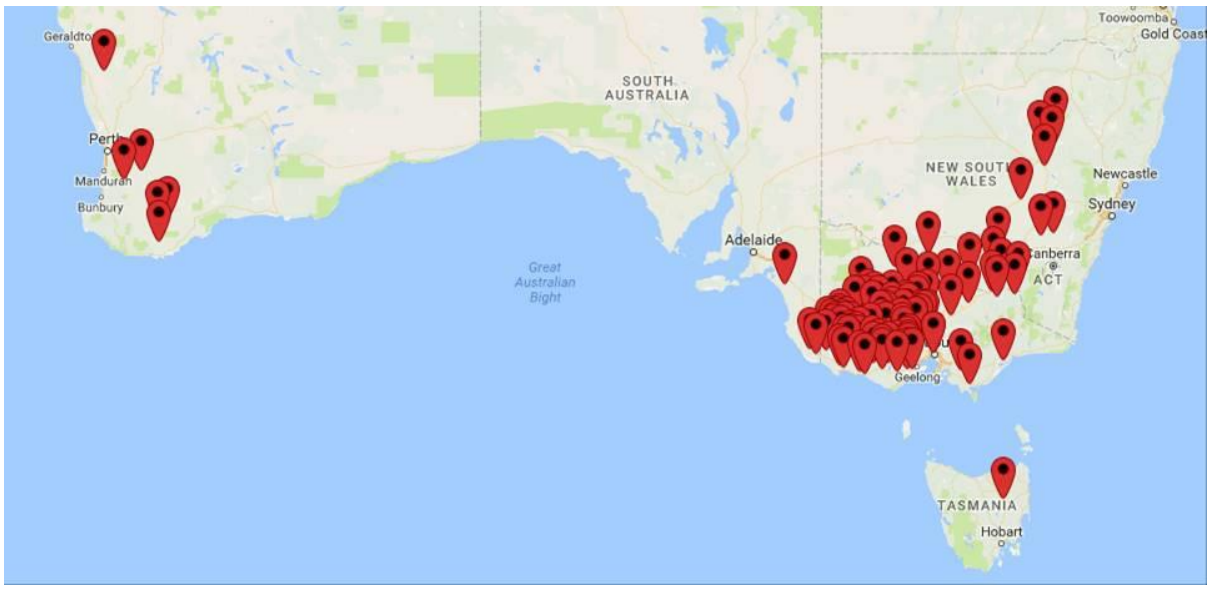

Figure 7. Geographical distribution of sheep producers surveyed regarding scanning.

Approximately 40% of participants were from prime lamb enterprises with 20% Merino only growers and the balance mixed merino and lamb enterprises. Total hectares ranged from 40-20,000 with an average land area available for grazing livestock of 1356 hectares. Time of lambing varied between April and October with the greater majority of respondents lambing in May, June or July.

Of the 153 completed questionnaires, only 19 producers (12%) were not scanning to determine reproductive potential (multiple foetuses). When offered the opportunity the majority (85%) of producers not currently scanning for multiple births identified that they would be interested in

understanding the reproductive potential (multiple births) in their flock. However, in consultation with a proportion of scanners, it became apparent that this is a standard approach in client engagement. That is, competent and confident scanners are already discussing these options with clients. In these regions, scanning for multiple foetuses is standard practice. In areas where this is not the case, it may be that either scanner competency or traditional management approaches and mindset are the greatest barriers to optimising the potential of scanning as a management tool. While producers demonstrated an interest in identifying the percentage of multiple bearing ewes, simply offering a voucher to cover the cost is unlikely to satisfy this desire. The most likely reason existing scanners are not already implementing this, is due to a lack of skill in scanning for twins.

For this sample of producers there are already a high proportion of producers scanning for multiple foetuses. Whereas a small proportion of producers expressed that they are making active decisions against the use of this tool due to broader management issues preventing them from engaging. The following dot points outline the barriers to adoption/difficulties experienced by the producers;

- accuracy and competency of scanners,
- paddock numbers and size, for division of mobs into twins and singles for differential management,
- time of lambing (autumn vs winter/spring) generating an expected predominance of single births,
- pre-set/traditional (and incorrect) expectations around reproductive performance in Merinos,
- difficulties with mindset change for farmers, including use of scanning/technology/data,
- accuracy and therefore value of scanning based on previous history of use, and
- historical/inherent acceptance of attaining “industry average” performance.

If was found that almost 50% of the producers scanning multiples were not using that information to further allocate ewes to lambing mobs and paddocks. In contrast almost 40% of the producers that were scanning for multiples were requesting information on foetal aging in addition to multiple scanning.

Producers who have fully engaged with scanning as an essential tool in their management system and have a high level of confidence in the data generated, are (increasingly) seeking to utilise this diagnostic tool against reproductive performance and proactive strategic planning for the critical period across lambing, in terms of allocation of paddocks for multiples (including triplets), and time of lambing (early and late in joining period).

Scanning sector consultation

Seven experienced scanners in Victoria, NSW and South Australia have been consulted regarding the industry as it stands with respect to registration and service provision/accountability. These scanners are based at the following locations; John Connell, Lismore Victoria, Brendon Robertson, Albury NSW, Mathew Ipsen, Maryborough Victoria, Michelle Cousins SA, Mark Jenkinson, Casterton Victoria, George Simms Wagga Wagga NSW, Trevor Pearce, Young NSW.

The main issues raised were capacity for service provision and the diverse skill base within the industry reflected in a variable accountability for the standard of service delivered. That is, one of the inherent issues for the cohorts of producers already engaging with scanning but not utilising the data, is the capacity of the scanning industry to provide a high quality, repeatable service accountable to the individual scanner and to the scanning sector.

There are intrinsic issues in the scanning sector that were identified through through surveying, personal, group and industry level consultation with the elite scanner group engaged as part of this pilot. They are as follows;

- Capacity for increased service provision (skilled scanners have no further capacity to deliver a scanning service despite increasing numbers of requests from producers. The aspects specifically in demand are foetal aging and accurate identification of multiple foetuses (including triplets in some cases),
- Accuracy and repeatability - the diverse skill base within the industry is reflected in a variable accountability for the standard of service delivered. Scanners with less experience reflect a lack of confidence in the higher-level tasks/skills,
- Access to and cost of (independent) training opportunities (current training is provided by one commercial entity only), and
- Access to ongoing support and mentoring.

6.3.2 The 'scanning for the future pilot'

One-day workshop and discussion forum with working group

A one-day meeting/workshop was held in Melbourne on 14th October. Seven scanners from 3 states attended. These personnel were carefully selected and invited to attend and are regarded to be experienced personnel with a deep understanding of the industry, both from a business and whole-of-industry perspective.

Consultation and facilitated discussion covered the following agenda items;

A. Explore the opportunities and limitations in the development of a program for training personnel employed within the scanning industry. This will consider (but is not limited to), the key drivers for this process, the logistics for delivery of training (time of year and access to infrastructure, sheep, personnel etc), understanding of the diversity of skill and opportunities that already exist in the industry,
B. Explore opportunities, possibilities and limitations for the development of a system for registration and accreditation of scanner skill, competence and training, and
C. Discuss other components required to support this program eg. the role of producer education, understanding of adoption of scanning in the sheep industry.

In summary, the meeting agreed that a more accessible (geographically) training program should be made available and training should be offered on more than one or two occasions/locations to facilitate a high rate of participation and fit with scanner availability/season. There was a mixed response regarding content, with some scanners seeking an integrated or more broadly contextualised training experience (theory/skill) and others more focussed on a skill based process. It was agreed that a combination of these can be offered in a single forum, with scanner participants choosing for themselves which training they engage with. The main issue left unresolved with respect to training is that a single business (selling equipment) dominates the current training offered. Two attempts were made unsuccessfully to engage and collaborate with this group. It is the opinion of the project team that if independent training is to be offered, it should, if possible, be in collaboration with that already in existence. An in-depth process of sector engagement and consultation is recommended to ensure that the sector uptake would warrant the development and

delivery of additional training opportunities, given current uptake of training is low when examined as a proportion of scanners working actively in the sector. Initial discussion with MLA and AWI (December 2016) suggested that the most palatable formula for industry would be a subsidised model, moving to a user pays model over 2-3 years. Given the low uptake of training in this sector to date it is the project team's opinion that a thorough scoping exercise and further effort to develop a collaborative approach should take place prior to considerable expenditure on a training and/or accreditation program.

Scoping of existing training/models in vocational sector

As described in the next steps section of this report, the proposal for this work on going (beyond pilot phase) is to offer multiple (6) discrete training opportunities across a variety of locations and states. These days would capture both skill-based and integrated knowledge, offer opportunities for skill development and technical support, integrate a benchmarking or accreditation process and capture the needs of the participants for future development of further days.

Resources would be provided, based on existing industry programs (eg. Life Time Ewe Management) but tailored specifically to meet the needs of the scanning sector. This formula was developed based on consultation with the working group and the broader industry plus a scoping exercise to investigate what comparable models have been successful to date in the vocational sector.

Logistics and scoping for future accreditation/training days

An outline and resource development for the training days has been conducted as part of this pilot phase (please see under Training section below).

Accreditation;

To overcome issues with accuracy and repeatability, it was proposed that a process of accreditation could be made available against which scanners could register their level of skill, on completion of a formal process of assessment. There was some concern that the sector was not mature enough for this process, nor do they have a representative body, nor a means to adequately capture and maintain the data generated. Hence, the initial model would need to be a self-administered process, by which scanners could "self-promote" their skill level having gone through the process of accreditation successfully. An unresolved further complication requiring further discussion and scoping, lies with the fact that for the scanners able to demonstrate a high level of accuracy and repeatability cannot meet the current demand for their skills. Hence, it is the opinion of the project team that given the additional difficulties with registration of data from this process and the immaturity of the sector in general, that training may present the better option for short term ongoing activities if this project continues.

The criteria below developed based on discussions in the Melbourne meeting against which scanners will be accredited are as follows;

- Standardised approach to accreditation- a standardised approach to training and accreditation is required regardless of location, time of year or personnel involved. This will ensure that a minimum standard or requirement is met and that all people undertaking training and accreditation receive equal opportunity to achieve a given standard,
- Use EID – pre-scanned sheep- EID will be utilised to ensure that individual status is accurately recorded. It would be desirable that individuals undertaking training and

accreditation are also able to use this technology to support accurate reporting or results. Training will be provided on this technology,

- Requires accuracy and repeatability- personnel undertaking accreditation will be required to achieve minimum standards of 95% twinning (multiples) and 98% for pregnancy,
- Numbers of sheep to scan per participant- each participant will be required to accurately scan 100 sheep,
- Time for completion- it was agreed that time should not be a critical factor for completion of the accreditation progress as the correlation between speed and accuracy has been well described. However, given the requirement for scanners to perform to producer expectations regarding throughput, participants will have 30 mins to complete the process. Feedback will be given on time to completion, given this is a critical factor for any scanning business model and leverages accuracy under certain circumstances,
- Pregnancy status of ewes scanned-ewes should be presented between 45-85 days' post joining. This represents the optimal time for accuracy of scanning and will further support any messaging for preparation of sheep for scanning that will be also developed and extended as part of this project longer term,
- Scanning for multiple foetuses- it was unanimously agreed that participants should be required to perform beyond identification of pregnancy alone and accurately identify for multiple foetuses. In an "average" commercial enterprise the expected ratio of multiples (twins and triplets), singles and dry ewes is 50:40:10. Ewes will be selected to full fill these criteria for accreditation,
- Preparation of sheep prior to scanning- sheep presented for scanning should be empty of food and water for 14 hours to facilitate clarity of image and support optimal accuracy,
- Age of sheep- it is widely recognised that older ewes have a greater variety of presentation of uterine placement, size and therefore image on ultrasonography. It was proposed that where possible 4-5-year-old ewes should be used for the accreditation to ensure candidates can accurately identify pregnancy status under those circumstances, and
- Breed of sheep- Merino sheep are the preferred breed for the process as they present the most common and challenging (variability) situation in the field. This will ensure that personnel undertaking the process can tackle day to day scenarios presented.

Training;

The outcomes and understanding developed during the days will be assessed using a participant questionnaire at the start and end of the sessions. Assessment is formative and feedback will be both encouraged from participants, and provided to them for activities throughout the day.

Introduction and overview for the day

Participants will be given a brief overview of the project and the day ahead including the activities and the process of accreditation.

The process of accreditation has been allocated 30 minutes to scan 100 sheep. Up to 1 hour can be facilitated for scanners bringing and setting up their own equipment. However, as it is likely that several scanners will present from one business, it is assumed that they will use the same equipment, reducing this time component. This is something that may need to be accommodated at

future training and accreditation days as it is preferable (expressed by the scanners) that they use their own equipment. Multiple stations for accreditation can be set up to accommodate larger numbers of participants.

The final model and timing for the day will be further refined. There will be a number of stations/activities that the scanners will complete, plus the accreditation process. The areas to be included as stations will cover the following;

- Pre and post workshop survey to capture baseline and then skill and knowledge development and outcomes,
- Consultation and information collection; an opportunity for the participants to provide feedback against specific criteria on the process of training and accreditation that scanners have been exposed to to-date. This will be offered as a group activity with the option to talk in confidence to one of the trainers/project team,
- Demonstrating the value of differential management; this will take the form of a combined coaching/discussion/workshop session to gauge and then support participant's competence and confidence in understanding and communicating the benefit of scanning for management and welfare,
- Discussion and evidencing (literature/data) for understanding speed of scanning, accuracy and price (especially for differentiation of singles/multiples). The imperative here is on accuracy with respect to producer perception of the value of scanning based on experience (direct or indirect) and associated accuracy, and
- Wrap up and feedback/participant survey.

Resources will be provided to participants in hard copy and electronically (USB).

Conclusion;

This pilot phase has identified 2 key components that are considered the main barriers to adoption of scanning in the sheep industry currently;

1. The lack of accuracy and repeatability or variability in skill level of scanners. This also includes a paucity of scanners able to provide accurate results for multiples and foetal aging.

2. A broad producer perception that scanning is not a cost-effective tool, or there are additional on-farm management issues that stop the employment of this data to its greatest effect.

Based on the information collected as part of this pilot phase, it is the opinion of the project team that although the scanning sector would benefit greatly from both a process of accreditation towards an accountable service, plus additional training opportunities, based on robust and industry relevant information, the sector is not yet mature enough to undertake these activities alone. It is anticipated that if additional training is offered, this would need to be heavily subsidised to encourage a higher level of participation than is currently experienced by the commercial provider. That is, provision of training is not the only issue, with uptake and engagement from the sector as a whole an outstanding issue concurrently. Engaging with the commercial company currently providing training (the only available) would also augment this process. This has been explored as part of this pilot and provides additional challenges in collaboration.

The fact that the sector does not have an independent representative body, nor one to lobby on their behalf also presents difficulties both in supporting any formal process of registration and accreditation. This presents significant challenges in terms of adequately reaching all members of the sector for promotion of activities and opportunities, or for consultation.

7 Current and future extension strategy and the next step with pilot programs

Given that only 26% of Australia's ewes are scanned for multiples (Table 19) and the fact that based on producer surveys, typically less than 80% of those producers scanning for multiples differentially manage singles and twins post scanning, this means that only 20% of Australia's breeding ewes are managed according to their nutritional requirements. This is the primary reason why in excess of 12m lambs are lost in Australia each year, which according to Young et al. (2014), based on 2013 prices, was worth over $700m in potential profit. However, based on today's lamb price of $6.00/kg carcass weight, at an industry level the cost of lamb survival is even more profound, estimated to be almost $1b in potential profit lost per year. When you consider that producers who adopt pregnancy-scanning for multiples and differential management of singles and twin increase whole-farm lamb marking rates by 14%, primarily driven by improved lamb survival, much of the $1b profit can be realized with more widespread adoption of known, proven practices. These gains can now be ever further enhanced by applying recent research findings on the allocation of twin bearing ewes to better paddocks for lambing based on shelter, privacy (mob size), feed quality, less predation and better historic performance. However, while such a significant proportion of Australia's breeding ewes (approximately 80%) effectively remain un-managed, it is no wonder our national marking rates vary so markedly from year-to-year. This volatility affects not only the individual producers, but the collective industry and the entire value chain of both sheep-meats and wool by threatening continuity of supply to key markets and contributing to extremely volatile pricing for our end users. Not to mention the welfare concerns and potential social license implications for Australian sheep producers of ongoing high lamb mortality rates, yet the industry has a lot of the technical understanding to significantly improve these outcomes.

The core issue is a lack of adoption of recognised best practice for improved reproduction rates, particularly scanning for multiples and differential management of singles and twins. The key reasons for the lack of adoption of best-practice resulting in about 80% of Australia's ewes not being managed according to requirements are;

- A lack of recognition of the true level of lamb loss, with all producer segments and producer influencing segments of the Australian sheep industry surveyed, over estimating lamb survival rates, in particular producers that don't scan for multiples (75% of Australian producers),
- A lack of understanding that the majority of lamb loss is under the producers control,
- A lack of awareness that scanning for multiples and differential management of singles and twins significantly improves lamb survival and flock profitability,
- Some producers scanning for multiples not using information to full effect by either not differentially managing singles and twins and/or not effectively allocating resources (feed, shelter, paddocks, labour and fencing) on a whole-farm basis to improve lamb survival,

- Too large of mob sizes of lambing ewes compromising privacy during lambing resulting in poor lamb survival in twins due to exacerbating miss-mothering,
- Mixed messages from consultants on the value of scanning and nutritional management to improve lamb survival, in fact active advocacy against the adoption on these practices,
- Lack of capacity from pregnancy scanners to deliver scanning for multiples with the required accuracy and repeatability and mixed messages from scanners to producers about ewe management and target survival rates for singles and twins due to a lack of understanding,
- Lack of recognition of the importance/impact of reproduction rate and lamb survival on the entire value chain, from producers, to processors, and ultimately consumers.

When you consider the $1b opportunity that exists for the sheep industry in potential profits from improving lamb survival, plus the even bigger down-side risk of consumer and community support identified in the MISP, the current investment from MLA and AWI in Development and Extension (D&E) activities of about $2m pa seems disproportionately low. Especially when you contemplate the scale of the industry with 31,136 farm businesses with sheep and lambs (ABS Agricultural Commodities 2015-16), carrying almost 40m breeding ewes and their followers. The main activities that are funded currently that have a significant degree of focus on sheep reproduction and lamb survival include;

- It's Ewe Time Forums- which is an awareness event run nationally every couple of years,
- Bred Well Fed Well- 1-day workshop on the role of genetics and nutrition on reproduction,
- Realising Performance Potential- 1-day workshop on skills to identify performers from passengers, and
- Lifetime Ewe Management- 6 session supported learning package that builds foundation skills in condition scoring and feed budgeting to manage ewes to a target condition score profile.

Others extension activities that MLA and AWI invest in that have some emphasis of sheep reproduction and lamb survival include;

- AWI State Networks,
- AWI Wild Dog Control,
- MLA Producer Demonstration Sites (PDS), and
- LambEx- biannual national sheep conference.

Other extension activities worth recognizing that have a significant emphasis on lamb survival, but are no longer funded include;

- Lamb Autopsy Workshop- 1-day workshop on the cause of lamb loss and ways to intervene,
- Managing Ewe Potential- formerly known as the Managing Scanned Ewe Workshop, and
- More Lambs More Often- 1-day workshop on managing sheep in a variable climate.

7.1 Pregnancy scanning demonstration sites

Purpose: To demonstrate the benefits of pregnancy scanning for multiples and differentially managing single and twin bearing ewes on lamb survival rates and marking rates.

Target audience: Non-adopting producer segments (producers that don't scan or wet-dry scan only) and consultants that are perpetuating disparaging messages to industry about the virtues of scanning.

Given that 50% of sheep producers don't pregnancy scan at all and a further 20% scan for wet-dry only, and the continued recommendation by well-recognised sheep consultants that pregnancy scanning ewes for multiples doesn't pay, it is necessary to initiate an intervention to address this situation.

Format: To establish a demonstration on 500-1000 ewes of pregnancy scanning for multiples and differential management of singles and twins to quantify the impacts on lamb survival and marking rates compared to non-scanned ewes on the same farm. With the aim of involving a group of local producers that primarily don't yet scan for multiples, to engage them in the demonstration process and outcomes, to provide a supported learning environment for wider adoption among the group.

The proposal for MLA and AWI to consider would involve 5 states, each with 2 demonstration sites per year, therefore totalling 10 demonstration sites nationally per year. The target participants would primarily be farms that benchmark their business with consultants that don't believe pregnancy scanning is worthwhile. The basis to the proposal being;

- **Why**- (i) need good economic case studies on cost-benefit of multiple scanning,
  (ii) the target producers are often large enterprises with very strong opinions, and
  (iii) take on consultant message to prove lifting reproduction adds value and profit.
- **How**- identify potential candidates (list already compiled) and approach directly,
- **What**- multiple scan up to 1000 ewes and differentially manage to demonstrate benefits,
- **Cost**- to organise, scan, manage, collect marking data, conduct economics, and write case study is around $10,000/site for 10 sites = $100,000/year, and if it was done for 2 years (ie. 20 sites) then the total project would cost about $200,000.

After two-years the project would have directly engaged with at least 100 non-adopting producers (20 sites by 5 non-adopting producers per site) and generated numerous case studies for wider dissemination promoting the virtues of scanning for multiples and differential management. In addition, a number of consultants with disparaging messages about the benefits of pregnancy scanning and the value of improving reproduction rates will have been directly combatted with the outcomes of these demonstrations.

7.2 Lambs Alive

Adjusted for seasonal impacts the real gains in marking rate by LA participants are around 7%, and in addition about a 10% improvement in whole-farm stocking rates. These overall impacts are comparable with those achieved by LTEM graduates. In the next section of this document, based on a more conservative 5% improvement in marking rate and stocking rate, the benefit-cost ratio (BCR) for LA is 6.1 to 1. Hence present a justifiable value proposition to industry (MLA and AWI) to invest in a national roll out of the program.

Currently one pathway being proposed to deliver LA is through the Profitable Grazing Systems (PGS) program recently established and funded by MLA. The cost per business to participate in LA (assuming a group of 10 businesses) based on the cost estimates outlined in the previous section would be $1600. If LA was to be delivered in accordance with the PGS funding guidelines that would mean producers would contribute $1000 per business and the balance of $600 could be claimed through PGS. Although much of the LA content has been developed and piloted, there is continuous improvement required based on the feedback from the pilot program evaluation and to qualify as a 'supported learning package' (SLP) in PGS the evaluation processes will need further development,

most likely incorporating much of the post-course evaluation developed in this project plus some within program formative evaluation through the sessions as they occur. A discussion has already been held between Lyndon Kubeil, the Victoria State Coordinator for PGS and two of the original LA development team, Ken Solly and Tim Leeming, to progress thinking along these lines. Approval for this to occur from AWI will be required.

There are some limitations with the approach to roll out LA within PGS. These include;

- there is an annual limit in each state to the number of SLPs that can be run, about 7 in each states, and these SLPs should be run across a range of topic areas,
- each consultant/deliverer can only run 2 SLPs in a year, which is a significant issue for LA given the caliber of deliverer that is required for LA,
- without centralized (national) management of LA, instead being overseen by each state coordinator, causes concern for the consistence of delivery of LA particularly while it requires continuous improvement and further development.

These concerns about the PGS pathway for rolling out LA are not necessarily a reflection on PGS but the concerns are heightened by the experience with LTEM in recent years, with a mature defined package, that has decline in its impacts primarily due to substantial variation in deliverer quality and administration.

An alternative and warranted pathway to deliver LA could be to submit the following project proposal into MLA (perhaps targeting MDC funds if there are no MLA levy funds available) and AWI. The details of the LA national roll-out proposal include;

- 4-year proposal to deliver 25 groups per year in Vic, SA, NSW and WA, totaling 100 groups,
- At an average of 10 producers per group, the program would reach 1000 producers,
- LA would be delivered by the best 10-12 available deliverers nationally based primarily on benchmarked performance from LTEM delivery and would include names like Ashley Herbert and Paul Omedei (WA deliverers), Ken Solly, Hamish Dickson and Daniel Schuppan (SA deliverers), Tim Leeming, Jason Trompf and James Whale (Vic deliverers), Geoff Duddy, Chris Mirams and Rob Inglis (NSW deliverers),
- The project cost would be approximately $550,000 per year including administration and evaluation of which the producer contribution would cover almost half ($250,000) and the balance would be funded by a combination of MLA/MLA MDC funds and AWI funds,
- This proposal would also cover continuous improvement and further development of the LA package and costs associated with training-the-trainers, and
- By the completion of the 4 years an extra 750,000 will have been produced from the farms engaged, based on the engagement and impact figures generated in the LA pilot program.

The approach outlined above, commencing in 2018, will make a significant contribution to the SISP plan targets for nation reproduction rates by 2021.

7.3 Pregnancy scanner capacity building

The following activities are proposed as the next steps in this program. These activities are informed by the process of consultation undertaken in the pilot program. This has formed the most diverse

and insightful scoping work conducted to date in this sector and will support the development of a robust and relevant program for training and accreditation activities.

This first task would be to benchmark scanners from the working group and a cohort of less experienced scanners to establish and reinforce existing data for accuracy and repeatability. This will then be used to inform the process and expectations in the accreditation process.

It is recommended that a group of scanners be engaged to scan 100 ewes that fit the criteria set by the elite scanner group (as detailed in this report). Scanners will also complete a short assessment to determine their experience (numbers scanned per year, length of time in the industry, training completed etc) to produce an objective classification against which their results will be compared. It is expected that there could be a difference of up to 25-40% in accuracy and repeatability between the most experienced (elite) scanners and less experienced scanners working full time in the industry. However, as there is no data for this industry, this is an estimate. On this basis, it is recommended that at least 5 “elite” and 5 less experienced scanners (less than 5 years’ experience) are compared in performance scanning 100 ewes twice each. This should produce data with a 90-95% confidence interval if the estimation of a 25-40% difference in outcome is correct. Accuracy can be compared/correlated with experience as classified through the questionnaire as proposed.

Based on work and consultation conducted in this pilot, a proposed benchmark for accreditation of less experienced scanners is; 95% accuracy for litter size and 98% accuracy for pregnancy. This process will establish, if this represents the diversity in experience, accuracy and skill that exists in the scanning sector. Further discussion and consideration of the user-pays versus industry subsidised models for training provision and support is required prior to the development and delivery of independent training and/or accreditation program.

This further development and testing of an independent training program for pregnancy scanners is estimated to cost $25,000. Without the scanning industry having a representative body, the cost of this proposal would need to be borne by MLA and AWI. The subsequent goal would be to run training programs for scanners in each state. The scoping and full costing of this national proposal would be undertaken as part of the development project outlined above, including exploring the potential collaborators that could co-invest in the national project, including the contribution scanners themselves would make.

7.4 Resources for regional campaigns

A concept that should be further considered for development by MLA and AWI is to have of a contingency fund to support regional based campaigns on lamb survival based on exceptional circumstances, such as drought conditions. The most recent example that would have warranted funding was the terrible first half of this year in WA. By the time local resources (DAFWA etc) and content was arranged it was July before workshops were delivered for producers across the state, by which time it had rained. The purpose of the campaigns would be to support producers when they need it most and overtly encourage the adoption of best practice (scanning and differential management) to cope most effectively with varying seasonal conditions. The aim would be to minimize the currently fluctuations in national marking rates by targeting ‘hot spots’ each year.

7.5 Establish a lamb survival working group with Sheep Producers Aus.

To oversee the development of strategy for sheep reproduction and lamb survival across Australia, a steering committee has been established under the new Sheep Producers Australia organization. More detail on the composition of this group is outlined in the recommendation section of this document. The steering committee has been established with input from MLA, AWI, Sheep Meat Council, Animal Health Australia, Sheep Genetics.

8 Investment plan development to achieve MISP and SISP targets

In 2013, the Red Meat Co-Investment Committee commissioned the development of the Sheep Reproduction RD&E plan (Trompf et al. 2012), as improving reproduction was identified as the highest priority following development of the National Sheepmeat RD&E strategy (2010). In addition to stakeholder consultation, a key feature of the process undertaken in developing the Reproduction RD&E plan was a robust economic analysis of the value of improving sheep reproduction and identification of the components of the reproductive process that should be the priority for further RD&E investment (Young et al. 2014). The analysis highlighted that improving lamb survival, especially twin lamb survival from Merino ewes, as the area with highest pay-off. A detailed 'Rapid Appraisal Benefit Cost Analysis' was also undertaken on more than 50 project concepts submitted by stakeholders and MLA subsequently invested about $3M in 15 different projects which have mostly finished or in their completion phase. In addition to funding Lifetime Ewe Management, AWI initially co-funded two of the 15 projects with MLA, however withdrew funding from one during the course of completion.

Since then, the process for commissioning R&D has changed. MLA now has a consultation model driven by the Southern Meat Research Advisory Committee and the Western Australian Livestock Research Advisory Committee. These two committees collate industry priorities that inform the development of the 'Terms of Reference' to go to open call. In 2016/17, the Terms of Reference did not call for projects on lamb survival.

The most recent open call, to inform 17/18 investment, included a Terms of Reference focused on breeding enterprise management to which projects that focused on improved reproductive success were submitted. It is not known how many of these projects were invited to submit full applications or how many have been recommended for funding. The MLA Donor Company (MDC) has also recently invested in projects relating to lamb survival (the details of which are unknown to their authors of this report) and at this time the processes AWI will adopt to invest in reproduction are also unknown.

The Australian sheep meat sector aims to improve national marking rates by 5% by 2020 (SISP 2020) and 15% by 2030 (MISP 2020). Improving ewe and lamb survival is also a key component of the MISP objective to improve the welfare of animals within our care by monitoring and reporting to identify problems and to enable corrective actions and capture continuous improvement of welfare. The purpose of this section is to review the impacts of currently funded projects, plus projects we are aware of that are under consideration for funding or unfunded but identified previously as a high priority, in relation to the MISP and SISP targets.

The 'Rapid Appraisal Benefit Cost Analysis' tool (National Reproduction Strategy, Trompf et al 2012) was used by Farming System Analysis Service to estimate the benefit cost ratio of 16 current RD&E projects and their impact on the meta-targets relevant to SISP and MISP. The 16 projects include those that are known by the authors of this document to be either; (i) currently funded, (ii) under consideration for funding and (iii) projects that have been scoped but are unfunded.

8.1 Evaluation Framework

The evaluation process that is outlined below produces both a Benefit Cost analysis and calculation of the impacts of the project on the Reproduction Meta-Targets - Weaning %, and Annual Wastage as a result of ewe and lamb loss.

8.1.1 Background

The 'Rapid Appraisal Benefit Cost Analysis' tool (National Reproduction Strategy, Trompf et al 2012) was used by Farming System Analysis Service to estimate the benefit cost ratio of 16 RD&E projects and their impact on the meta-targets relevant to MISP and SISP.

It is based on an economic analysis of the on-farm benefits calculated using the MIDAS model, and information for each project including the projects costs and, the expected on-farm benefits and costs if each project is successful. The following outlines the system used and the economic analysis of the on-farm benefits that underpins the Rapid Appraisal analysis.

8.1.2 The MIDAS Analysis

Model Description

The analysis was carried out using the South West Victoria version of the MIDAS model and has been described in detail by Young et al 2014. MIDAS is an appropriate analysis technique because it is able to quickly and efficiently value the impact of improving reproduction on survival whilst accounting for the other related production and management changes that result or are necessary to maximise the value of increasing reproductive rate. The design and production assumptions included in MIDAS that are relevant to an analysis of changing reproductive or survival rates:

1. Inclusion of a full self-replacing flock with breeding ewes, lambs, replacement ewes and a wether component if relevant. This ensures that the implications of reproductive rate on flock structure are fully accounted for, which includes the proportion of ewes to dry sheep, the change in age structure and the number of young sale animals and older sale animals.
2. Inclusion of a detailed feed budget that accounts for the change in energy requirement and intake capacity of dry, single and twin bearing ewes through gestation and lactation. It also accounts for the extra liveweight gain of reproducing ewes after weaning.
3. Wool production (CFW & FD) varies with the age of the ewe, and the age structure of the flock can change with increasing weaning %. The assumptions on wool production by age are based on measurements from the Base Flock in Katanning WA.
4. Ewes bearing twins have a higher energy requirement during late gestation and during lactation than single bearing ewes
5. Ewes bearing twin lambs produce less wool that is finer than ewes bearing singles and ewes bearing singles produce less wool that is finer than dry ewes.

6. Survival of twin lambs is lower than survival of single born lambs
7. Animals that were born as twins produce less wool that is broader than animals that were singles.
8. Lambs from young dams produce less wool than lambs from older dams. The assumption is that lambs from 2yo dams produce 100g less CFW than lambs from older dams and that the penalty is double for lambs from 1yo dams.
9. Increasing scanning percentage alters the proportion of dry, single and twin bearing ewes (Figure 86). The proportion of dry ewes decreases and the proportion of twin bearing ewes increases and the proportion of single ewes increases up to about 100% scanning and then begins to reduce.

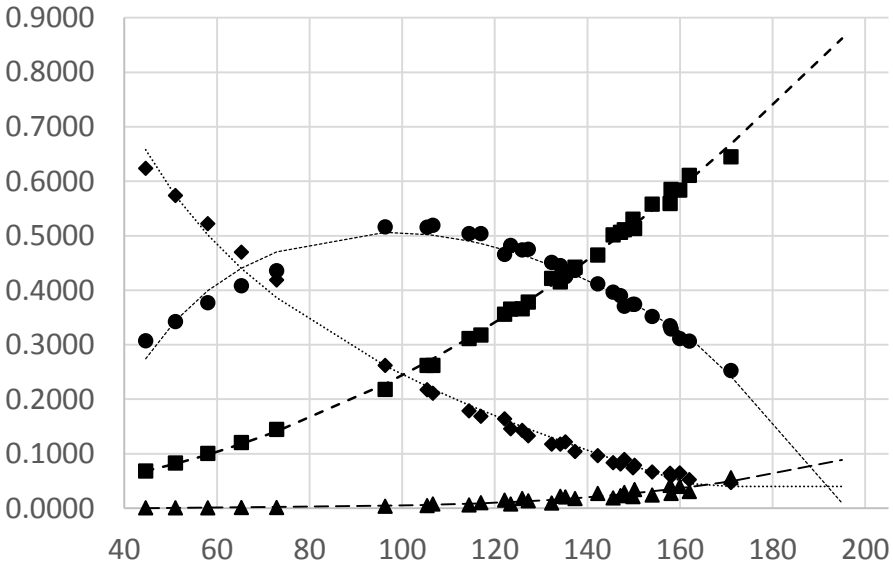

Figure 8. Proportion of dry, single and multiple bearing ewes (◊ Dry, ● single, ■ twin and ▲ triplet) with varying scanning percentage. (Source Cranmore Park.)

The components of reproduction were valued for each of 3 different flock types;

1. Merino - Merino: A self-replacing flock with a focus on wool production in which merino ewes are mated to merino rams. The wether component of the flock was sold at either 10 months, 17 months or 29 months of age.
2. Merino - Terminal: A self-replacing flock, with a dual focus on wool and lamb production. This incorporates a merino-merino self-replacing flock in which surplus ewes are mated to a terminal sire for production of finished first cross lambs.
3. Maternal: A self-replacing flock based on a composite genotype selling finished lambs.

Results

A result that is important in order for these results to be used in the BCA is that the increase in profit is linearly related to reproduction rate (Figure 9). This means it is possible to multiply the expected increase in production by the slope of the line to get the expected total increase in on farm benefits.

The value of increasing reproductive rate is higher for the Terminal & Maternal flock than the pure Merino (Table 36). This is predominantly due to the higher sale value of the lambs and for the maternal flock the higher sale value of surplus young ewes and older CFA ewes.

The analysis provided the value for an extra single or twin lamb weaned, and the value of increasing weaner and ewe survival.

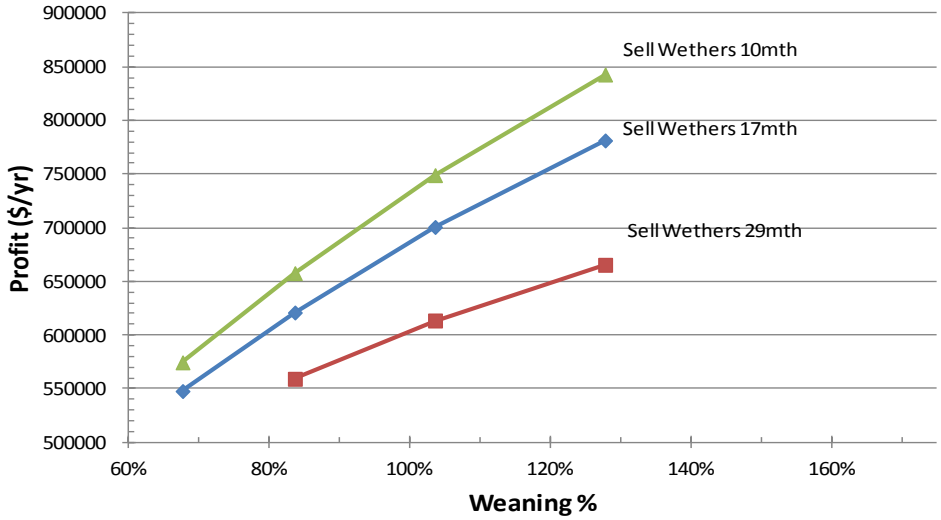

Figure 9. The increase in profit is linearly related to reproductive rate.

Table 36. MIDAS values calculated for the increase in profit from an incremental increase in different components of the reproductive process.

Component	Units	Merino – Merino	Merino-Terminal	Maternal
$/extra single lamb weaned	$ / lamb	75	84	73
$/extra twin lamb weaned	$ / lamb	56	81	73
Weaner Survival	$ / weaner	84		96
Ewe Survival	$ / ewe	176	192	196

The value of an extra single merino lamb weaned is greater than the value of an extra merino twin lamb because adults that were born as twins have a lower wool cut and higher FD, which reduces the value of the adult wool clip

Increasing conception rate increases the proportion of twins conceived and reduces the proportion of singles, and because twins have a lower survival rate a 10% increase in scanning typically only leads to a 5% increase in weaning rate. The higher proportion of twins also means a reduction in wool production in the adult flock.

8.1.3 The rapid appraisal benefit cost analysis

Project Proforma:

A Project Proforma was developed and then completed for each project. The Proforma includes high level information relevant to each project and the likely impact of the projects on industry.

The components of the Benefit Cost analysis that are reflected in the Proforma are:

1. Target Sheep population
2. On-farm Benefits (OFB) and lag from increasing expenses until benefits are received
3. On-farm Costs (OFC) either or both of an annual operating cost or a one off capital cost.
4. Probability of Technical Success (Success %)
5. Cost of the Research (RC) both the AWI expense and co-investment by other parties
6. Level of peak adoption (PA)
7. Lag to start of adoption (Lag)
8. Time required to achieve peak adoption (TPA)
9. Time to complete dis-adoption (TDA)
10. Discounting rate is 5%

Target Sheep Population

The research projects targeted different segments of the National Flock based on flock type. Statistics & estimates provided by Kimbal Curtis were used to quantify the number of sheep in each sheep class and each flock type (Table 37). The assumptions used to derive these values are outlined in Tables 38 and 39.

Table 37. Estimates of sheep numbers (m hd) derived from values provided by Kimbal Curtis (pers comm).

Sheep Class	Flock type		
	M-M	M-TS	Maternal
Mixed age ewe (3+yo)	14.2	4.7	8.4
Maiden ewe (2yo)	5.6	0.4	3.0
Weaners (1yo)	13.5	0	3.7
Wethers & Dry Ewes	19.1	0	0

Table 38. Information used to derive the sheep numbers (K Curtis pers comm.)

State	Total sheep	Breeding Ewes	Prop'n of ewes that are:		Prop'n of Mer ewes
	(m hd)	(m hd)	Mated	Merino	M-M
NSW	26.7	15.4		67	74
Vic	15.4	8.5		50	83
WA	14.4	8.0		83	78
SA	11.0	6.0		71	66
Tas	2.8	1.5		59	88
Qld	2.3	1.3		77	86
National	**72.6**	**40.7**	**92**	**67**	**76**

Table 39. Sheep numbers used in the BCA analysis (m hd)

Segment	Merino – Merino	Merino-Terminal	Maternal
Propn of ewe hgts mated	3%	0	28%
Number of lambing opportunities	4.5	5	4
Ewe Death Rate	6%	5%	4%
Propn Ewe Lambs sold at weaning	0%	100%	40%
Propn Wether Lambs sold at weaning	20%	100%	100%
Propn of Ewe Hgts sold	30%	0%	0%

On Farm Benefits

To estimate the total on-farm benefit, the benefit of a unit increase in the different production components was multiplied by the expected increase that would be achieved from each research project. The value of a unit increase in each component could be calculated from the MIDAS values by combining the relationship between scanning % and the proportion of ewes that are dry, single or twin bearing, with the MIDAS values for an extra animal to calculate increase in profit per animal per unit increase in the relevant component.

A total of nine components were included and these were the basis of the on-farm production increases that were included in the project proformas. These include;

1. Conception & Early Embryo Mortality (CEEM)
2. Single lamb survival (LS – Single)
3. Multiple lamb survival (LS – Twin)
4. Ewe mortality (Ewe Mort)

5. Survival of weaners
6. Weight of weaners
7. Survival of weaners (WS)
8. Value of wool and
9. Value of sale sheep

The magnitude of the total on-farm benefits could be calculated with the following formula:

Total Benefits = Value of a Unit of benefit (from MIDAS) x Number of Units (from Proforma) x Number of animals

For some projects there is a lag between when a practice is implemented and when the farmer receives the benefit. This can occur if the age group treated is different from the age group that are responding e.g. increased feeding to weaner to achieve improved weaning rate from maidens. This is reflected in the 'Benefit Lag'.

A detail not accounted for in the rapid appraisal BCA is any change in price received by the producer resulting from the shift in the supply curve due to the improved on-farm production. Inclusion of this detail would reduce the BCR of each project but only have a minor impact on the ranking of the projects because each project is having a similar impact on the supply curve.

On Farm Costs

This includes any costs that farmers would incur in order to implement the message or product on farm. The MIDAS analysis includes the cost of feeding the animals once they are pregnant or lactating or once they have survived, but it doesn't include the cost of improving the reproductive performance i.e. MIDAS values the consequences but not the intervention cost. The costs of intervention are entered in the BCA as a cost per animal and include both annual operating costs, such as extra supplementary feeding, and once off costs such as the cost of attending a training course or installing capital equipment such as fences.

Technical Success

This is an estimate of the probability that the project will deliver findings that leads to practice change amongst producers. In this manner it is a combination of whether an outcome similar to that which is expected is achieved and the probability that the finding can be converted into a message/product that producers will adopt.

Research Cost

This is the estimate of the total cost incurred in doing the RD & E associated with the project. This includes both the expenditure from MLA/AWI and any co-contribution from the research organization or other institution. For projects that have a research focus and that don't include a significant adoption phase in the project budget, an extra 'general extension project' with appropriate cost and benefits has been estimated to cover the extension work that will be necessary to achieve adoption.

Peak Adoption

This is an estimate of the total number of producers that will implement the technology or knowledge. The estimate reflects the adoption strategy that is outlined in the proposal or that is budgeted in the extra expense outlined above.

Adoption Lag

The lag to the start of adoption is the time from the beginning of the project until farmers begin to implement the findings. Longer lag times reflect projects that had to complete the research phase before any messages are likely to be available for farmers and shorter lag times if the research phase included farmer participation.

Time to Peak Adoption

This reflects the time it will take to convince all the producers who are receptive to the technology or knowledge to fully adopt the practice change for all animals in the flock. As the complexity of a technology increases, the time to reach peak adoption increases.

Dis-adoption

Dis-adoption is included in the framework to reflect two phenomena:

1. That the new technology/knowledge developed by the framework will be superseded and hence the outcomes of the project have a limited lifespan.
2. That in the absence of the project, farmers are likely to learn about or develop a similar idea or outcome from other sources.

In both cases the impact of the project diminishes over time and this is reflected in the length of the dis-adoption period.

Discounting

A discount rate of 5% has been used in this analysis and it reduces the value of benefits received in the future compared with costs incurred now.

8.2 Situational analysis for current reproduction RD&E – benefit cost and meta-targets outcomes

A total of 16 projects were evaluated in the Benefit Cost Analysis of the Reproduction Program. For each project the BCR of the project have been calculated over the life of the project accounting for the investment by MLA/AWI and any co-investment by other parties (Table 40). This provides the return on all monies invested in the research project. A leveraged BCR is also presented and it is calculated as the Benefits of the Project divided by the MLA/AWI Investment. This is a larger number that the standard BCR and provides the return on the MLA/AWI spend and shows the return achieved as a result of the funds leveraged by MLA/AWI.

The 'Rapid Appraisal Benefit Cost Analysis' tool (National Reproduction Strategy, Trompf et al 2012) was used by Farming System Analysis Service to estimate the benefit cost ratio of 16 RD&E projects and their impact on the meta-targets relevant to MISP and SISP. A summary of these outputs are provided in Table 25 and details regarding the assumptions underpinning this analysis can be made

available to MLA/AWI. To calculate the future meta-targets a generic Extension and Adoption project was included to represent the gains that are likely to be achieved from funding current and future E&A programs independent of the specific R&D projects. It is assumed that the extension budget will be approximately $1m per year.

The inclusion of this generic Extension and Adoption project ensures that the Meta-target estimate for 2030 is a realistic estimate of the impact that the current and planned R&D budget may have towards these future targets. The inclusion of the generic budget for E&A is not double counting of impacts because for most of the current and planned research projects there is a specific level of adoption that we have thought will occur directly associated with the project and the contact that producers have with the research work. In contrast, the extension project is packaging up all the messages and delivering to a wider audience. Bred Well Fed Well and Profitable Grazing Systems are examples of projects that could fit within this generic E&A budget, or at least the component of Profitable Grazing Systems dedicated to improving reproduction.

Table 40. Benefit cost and meta-target output for the 16 projects evaluated.

Project	Project Lifetime BCR		By June 2021		By June 2030	
	Leveraged	Standard	Increase in Weaning % (%)	Reduction in Wastage (000 hd)	Increase in Weaning % (%)	Reduction in Wastage (000 hd)
Funded projects						
LTEM	10.4	10.4	0.82%	-236	0.82%	-236
LTEM 2019-2021	11.9	11.9	0.16%	-47	0.97%	-279
Lambs Alive	6.1	6.1	0.03%	-9	0.03%	-9
Realizing Performance Potential	4.9	4.9	0.05%	-15	0.07%	-20
Wild Dog Control	10.5	10.5	0.66%	-306	0.70%	-324
Lambing Density	5.4	3.2	0.04%	-18	0.07%	-31
Sensors	5.4	5.4	0.00%	-1	0.08%	20
Sex Ratio	3.8	2.4	0.00%	-1	0.05%	4
Metabolic Disorders	2.4	1.7	0.00%	-1	0.01%	-4
Total Funded	**9.6**	**9.1**	**1.78%**	**-634**	**2.80%**	**-880**
Funding under consideration						
Triplet ewe and lamb survival	3.5	2.0	0.00%	-0	0.02%	-8
Foetal losses	2.9	2.0			0.02%	-8
Vitamin D&E	3.3	2.0	0.00%	-0	0.03%	-11
Total Under Consideration	**3.2**	**2.0**	**0.00%**	**0**	**0.07%**	**-27**
Un-funded Projects						
Maternal Ewe Lambs	3.6	2.9	0.00%	0	0.02%	3
Pregnancy scanners	7.9	7.9	0.01%	-5	0.03%	-13
Maidens	7.8	4.9	0.00%	-0	0.08%	-10
General extension budget	11.9	11.9	0.00%	0	2.03%	-584
Total Un-funded	**10.2**	**9.2**	**0.01%**	**-5**	**2.16%**	**-604**
Grand Total	**9.1**	**8.1**	**1.79%**	**-639**	**5.03%**	**-1511**

The analysis indicates that investment in reproduction RD&E is a good investment for MLA/AWI and sheep producers. The weighted average BCR for all the expenditure on the 16 projects is 9.1, indicating that for every $1 invested by MLA farm profit is expected to increase by $9.10. The average BCR was still 8.1 when the estimated in-kind contributions from stakeholders are included. As expected, the BCR for the extension-based projects are generally higher than the BCR for the research projects because they are using existing knowledge and there are no costs associated with development of new knowledge. However, given the widespread penetration of Lifetime Ewe Management and Bred Well Fed Well, engaging about one-third of the flock, future extension programs will only be effective for this significant cohort of the more open-minded sheep producers if outputs from new research continue to provide new and cost-effective solutions to reduce lamb mortality and improve marking rates. Hence, a balanced portfolio needs an appropriate mix of extension and research projects. Furthermore, innovative and targeted extension approaches will be required that engage the large proportion of producers (at least two-thirds of the flock) that to date have been less willing to participate in existing extension programs and have adopted best-practice a lesser degree.

Despite this apparent high return on investment from reproduction RD&E, and acknowledging that the list of projects in Table 40 may not be complete, based on the assumptions used it is inevitable that the impacts of current and planned investments in reproduction RD&E may only **achieve about one-third of the SISP and MISP targets by 2020/21 or 2030, respectively**. It is estimated that by 2030 that unless there is a substantial increase in the level of investment in reproduction RD&E that marking rates will have increased by only about 5% and lamb mortality will be reduced by 0.9-1.5M per annum. Furthermore, as about 40% of the expected impacts by 2030 may be attributed to the investment in new extension program, these programs will need to be targeted and effective. There is significant risk that PGS, which is more open-ended, producer driven and without well-defined products targeting the adoption of specific interventions to lift reproduction that it may fail to achieve the impacts needed to lift national marking rates. Put simply PGS was not designed with the sole focus of lifting. Also it is well documented that PGS is targeting the more innovative producers that are willing to pay a significant contribution towards their extension experience, which will most likely limit engagement of the wider producer community.

9 Recommendations

1. That a balanced portfolio of Research, Development and Extension be developed to address the goals related to sheep reproduction in MISP, SISP and the AWI Strategic plan, to ensure immediate needs are addressed by adequate extension and adoption activities and that future gains are informed and deliver by new R&D outputs.

2. MLA, including the MDC, and AWI develop a single 5 year reproduction strategy based on rigorous project evaluation which includes the projects contribution to the meta-targets in MISP, SISP and the Wool Strategy. Current funding is ad hoc and since 2013, when the Reproduction RD&E plan was developed, there has been limited cohesion between MLA and AWI in its implementation. Clearly since then MLA's model for consultation, priority settings and project selection has changed but consistently across SAMRAC and WALRAC priorities reproduction and lamb survival rates

extremely highly, so to have a consistent approach to appraising reproduction projects to ensure the best return on industry investment is still warranted. This appraisal process needs to include reproduction projects being funded via the MDC, which must be just as thoroughly evaluated as to their level of priority/effectiveness to lift marking rates and be embedded in the overall strategy.

3. That funding of projects aimed at improving reproduction rates and improving lamb survival be increased substantially to at least double the projected gains from current RD&E to ensure SISP and MISP targets are met. With the current level of funding it is estimated that the industry will only achieve about one-third of the SISP and MISP targets by 2020/21 or 2030. Although reproduction rates and in particular lamb survival are often identified in industry strategic plans as top priorities, if not the top priority, the area continues to be allocated inadequate funding in relation to the enormity of the problem and risk that exists. This issue will remain unless a fundamental change is made in the proportion of MLA/AWI funds allocated to improving reproduction rates.

4. To help achieve the required increase in funding it is recommended that MLA and AWI urgently agree whether or not to commit a lamb survival bid if there is a next round of the Rural Research for Profit Program.

5. To oversee the development of strategy for sheep reproduction and lamb survival across Australia, a steering committee has been established under the new Sheep Producers Australia organization. The steering committee has been established with input from MLA, AWI, Sheep Meat Council, Animal Health Australia, and Sheep Genetics. The steering committee has been put together to drive each of the key areas that need to be addressed to improve lamb survival and national sheep reproduction rates. The Steering Committee comprises;

- Chair (SPA Representative),
- 1 x Prime Lamb Producer,
- 1 x Merino Producer,
- 1 x Researcher,
- 1 x Economist,
- 1 x Geneticist, and
- 1 x Extension Specialist.

The first task of the steering committee will be to progress the review of the current RD&E undertaken in this project, to ensure a complete stock-take of current investments and impacts is undertaken as a starting point. This will involve the proponents of previous strategies such as Sheep Reproduction RD&E plan (2012) and AWI Reproduction Strategy. Subsequently the committee will develop the specific key action items for industry. Currently the steering committee that has been established is un-funded. The annual cost for travel and sitting fees is likely to be around $25,000 pa, with administration support provided by SPA.

6. Integration of the information gathered in this ‘strategy informing project’ to build a cohesive adoption strategy that establishes a learning continuum from awareness to widespread adoption. Currently that learning continuum is limited by a lack of funded adoption activities targeting lamb survival and sheep reproduction. Effectively at present there is Ewe Time Forums and other conferences such as Bestwool Bestlamb for building awareness, 1day workshops/feeder activities such as BWFW and Realising Productive Potential, and one key supported learning package in LTEM.

Both the producer's initiatives piloted in this project, Lambs Alive and Scanner Demonstration Project warrant further investment to be rolled out nationally. Lambs Alive provides another supported learning activity to drive improvements in lamb survival on a whole-farm scale and ensure producers are making full of their scanning information. Lambs Alive also fills the void left by LTEM Year 2 being removed, so that LTEM is now only a one-year course, focusing on foundation skills, which no longer has time to fully deal with whole-farm adoption issues, such as paddock allocation for lambing and resources allocation across the entire flock. The Scanner Demonstration Project is both awareness raising and supported learning for non-adopting producers of multiple scanning, which represent 75% of Australian sheep producers. In addition, by targeting producers that have been directly advised not to adopt scanning for multiples and differential management, it will provide a wave of momentum and positive outcomes to combat the consultants and advisors telling producers not to scan.

7. To further develop and test an independent training program for pregnancy scanners that will improve scanner accuracy and repeatability, and also ensure scanners are providing sound information to producers on targets for single, twin and triplet survival, management of ewes post-scanning and at lambing, and to sign-post producers to the relevant industry programs that are available to support producers.

8. Conduct a study on farms with existing benchmarking data to compare the performance of farms post the adoption of scanning and differential management, compared to a group of farms that have not adopted these practices. This will quantify the impacts of scanning for multiples and differential management on whole-farm profitability. It is a matter of urgency to generate economic validation of these practices to use nationally to promote increased uptake of practices that lead to more productive, profitable and ethical sheep farms.

10 Appendices

10.1 Appendix 1 – Lambs Alive course evaluation

Post Course Evaluation

Lambs Alive – Potential into Product

Preamble: For the continuous improvement of Lambs Alive, I am contacting you as a past participant to get your perspective on the program and its' impacts.

Section A – Farm characteristics

	Before LA	After LA	
Q1. What total farm area do you manage?			hectares/acres
Q2. What area of the farm was used for winter crop?			hectares/acres
Q3. What area of the farm was used for winter grazing (pasture)?			hectares/acres
Q4. What was the season like for lambing (poor/average/good)?			season type
Q5. How many bales of merino wool produced?			merino bales
Q6. How many bales of crossbred wool produced?			crossbred bales

Section B - Sheep productivity

Q7a. What was the total number and class of livestock on your property at weaning in 2015 (before LA) and at weaning in 2016 (after LA)? This data will be used to calculate a total DSE for the farm. Please include all breeding stock including sire types used, replacement breeders, rams/bulls, wethers/steers and any other stock as indicated in the table below.

Stock type and class (sheep and cattle)	Sire type	Number	
		Before LA 2015	After LA 2016
Merino ewes	Merino		
Merino ewes	Terminal		
Merino ewes	Maternal/Composite		
Maternal ewes (1st cross or composite)	Terminal		
Maternal ewes (1st cross or composite)	Maternal/Composite		
Dry sheep (weaners, hoggets, wethers, rams)			
Breeding Cows			

Dry Cattle including bulls			

Q7b. Do you intend to change stocking rates as a result of LA? Decrease Maintain Increase

Q7c. Explain how?
……
……

Q7d. If so, by how much do you intend to change stocking rate by 2018? 5% 10% 15% 20%

Q8a. What was the reproductive performance of the different types of ewes on your property in 2015, excluding ewe lambs (the year before commencing LA)?

Ewe type and age	Sire type	Joining date	No. ewes joined	No. of foetuses scanned	Scanning %*	No. of lambs marked	Lamb marking %	Lamb survival %
Merino ewes	Merino							
Merino ewes	Terminal							
Merino ewes	Maternal/ Composite							
Maternal ewes (1st cross or composite)	Terminal							
Maternal ewes (1st cross or composite)	Maternal/ Composite							

* Scanning percentage equals total number of foetuses at scanning divided by number of ewes joined.

Q8b. What was the reproductive performance of the different types of ewes on your property in 2016, excluding ewe lambs (after LA)?

Ewe type and age	Sire type	Joining date	No. ewes joined	No. of foetuses scanned	Scanning %*	No. of lambs marked	Lamb marking %	Lamb survival %
Merino ewes	Merino							
Merino ewes	Terminal							
Merino ewes	Maternal/ Composite							
Maternal ewes (1st cross or composite)	Terminal							

Maternal ewes (1st cross or composite)	Maternal/ Composite							

* Scanning percentage equals total number of foetuses at scanning divided by number of ewes joined.

Q9. Complete the following for your whole farm, for pre (2015) and post (2016) LA.

	Pre LA 2015	Post LA 2016	Intended 2018
Number of lambing paddocks for main lambing			
Average mob size for lambing twin bearing ewes			
Average marking % in twin mobs (main enterprise)			-
Average mob size for lambing single bearing ewes			
Average marking % in single mobs (main enterprise)			-

Section C – Skills and management practices

Q10a. Please rate your skill level (1=low skill, 5=high skill) in the following areas before and after LA?.

Skills & management practices – rate skill level (1-5) for:	Before LA 2015	After LA 2016
(a) Identify/understand primary causes of lamb loss and how to rectify		
(b) Estimating pasture quantity- feed on offer and quality- digestibility		
(c) Manipulating pasture production to achieve pasture targets		
(d) Accurately condition score ewes (can detect 2.5, 2.7, 3.0, 3.3 etc)		
(e) Calculate and correct ewe's metabolisable energy (ME) balance		
(f) Managing ewes to achieve target condition scores at key times		
(g) Differential management of ewes based on preg status and/or CS so that twins lamb at least 0.3 CS higher than singles		
(h) Making precise supplementary feeding decisions based on knowledge of feed supply, feed demand and ewe condition score		
(i) Paddock allocation at lambing- assess pasture, protection, privacy & past performance to inform allocation of twins and singles		
(j) Ability to plan resources needed for the whole flock from scanning to weaning & optimise whole farm resource allocation across flock		

Q10b. From the following list of different farming practices please indicate (tick √) the practices which you undertook as part of your normal farm management before LA and after LA (ie. not just during course)?

Farming Practices Used – Did you...	Before LA 2015	After LA 2016
(a) Autumn saving/deferred grazing of pasture to build feed wedge		
(b) Use growth promotants (eg. Urea) to increase FOO for lambing		
(c) Assess pasture quantity/quality to achieve key pasture targets		
(d) Condition scoring of ewes at weaning to prepare for joining and scanning to prepare for lambing		
(e) Draft ewes into different mobs based on CS & manage separate		
(f) Manage ewes to achieve condition score targets at key times such as joining and lambing		

(g) Scanning ewes for pregnancy status – dry, single and multiples		
(h) Scanning ewes for multiples and foetal age (ie. early and late)		
(i) Differentially manage single and multiple bearing ewes from immediately post scanning to lambing and to weaning		
(j) Calculate metabolisible energy (ME) balance (requirement versus intake) then adjust paddock and/or rations accordingly		
(k) Reallocate feed (supplement and pasture) away from singles to twins so that twins lamb at least 0.3 CS higher than singles		
(l) Assess pasture, paddock size, protection, privacy, predation & past performance to inform paddock allocation- twins v singles		
(m) Sub divide more paddocks (with either permanent or temporary fencing) to enable more smaller mobs for lambing		
(n) Lamb twins in smaller mobs and much small mobs than singles		
(o) Keep accurate lambing records by mob and paddock and use information to inform future paddock allocation for lambing		
(p) Joining length of 5 weeks or less		
(q) Quantify lamb survival rates across your whole farm and for all enterprises- by comparing scanning to marking %		
(r) Quantify breeding ewe wastage across flock each year- that is the percentage that die, are scanned dry or don't rear a lamb		
(s) Wet-dry ewes at marking/weaning (feel udders, draft off dries)		

Section D – Overall impressions of LA

Q12a. Have you made any changes to how you manage your sheep enterprise as a result of LA? YES NO

Q12b. List the key practice changes you have made as a result of participating in LA?

.....
……

.....
……

Q13a. Please rate your overall satisfaction with being involved in LA?

Not satisfied								**Very satisfied**	
1	2	3	4	5	6	7	8	9	10

Q13b. Do you have any suggestions as to how LA can be improved?

.....
……

Q14. Rank the LA Program on delivery, content and impact of your farm. Deliverer:
_____

Low impact

High impact

Delivery:	1	2	3	4	5	6	7	8	9 10
Content:	1	2	3	4	5	6	7	8	9 10
Impact of your farm:	1	2	3	4	5	6	7	8	9 10

Q15. Have you recommended LA to other producers? YES NO

Q16. On reflection, what would you be willing to pay to participate in LA?

.....
……

Q17. Is LA worth doing on top of LTEM and what did LA offer in comparison/addition to LTEM?

YES / NO

.....
……

.....
……

Q18a. Do you think producers could do LA without having previously done LTEM? YES NO

Q18b. Explain why/why not?
.....
.....

.....
.....

Q18c. What are the key skills producers need to participate in LA?
.....
.....

.....
.....

Q19. To continue to improve industry lamb survival rates, what aspects/gaps require further investigation?

.....
.....

Q20. Any closing comments?
.....
.....

Thank you for giving us this valuable feedback on LA, your input to the program is greatly appreciated.

10.2 Appendix 2 – Questions used to evaluate scanning demonstration case-studies

Scanner case study questions

Background on sheep enterprise:

_____

_____

_____

Historic lamb marking rates:

_____

_____

_____

Typical scanning practices:

_____

_____

Why?

_____

_____

Advice re scanning and from who?

_____

_____

Advice on importance of marking rates and from who?

_____

_____

Description of what was undertaken?

_____

_____

What (if anything) the process has encourage- changes and the triggers?

_____

_____

As a result of scanning for multiples, what were;

(i) Your first impressions of the scanning process and results for your sheep?

_____

_____

(ii) Comparison of your usual marking results with scanning result- learnings?

_____

_____

(iii) The decisions made following scanning- management, feed/paddock allocation?

_____

_____

(iv) The marking results that you achieved following scanning?

_____

_____

(iv) Comparison of your actual marking result to scanning result- learnings?

_____

_____

(iv) Challenges and whether you will continue scanning for multiples in future?

_____

_____

Many other producers don't scan for multiples- why is this so and can this process aid adoption?

_____

Thank you for giving us for the valuable feedback and involvement it is greatly appreciated.