

Maximising the Reproductive Potential of the Merino

From conception to weaning

A report for



by Tim Gubbins

2014 Nuffield Scholar

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Executive Summary

The following report aimed to investigate issues that relate to lamb losses from conception through to weaning. The information within comes from researchers, extension work and farmers experience.

This report is designed to assist sheep farmers, not only locally, but nationally, on how they can simply and effectively unlock the potential that exists within their own flock.

This research draws attention to the current national lamb survival figure which is currently 80% nationally and on average 30% of all lambs born will die prior to weaning at an estimated cost of \$56 million dollars.

Despite marked improvement in ewe and lamb nutrition, management and health control, this high post lambing mortality rate does not appear to have changed significantly during the past decades and it remains an intractable problem.

The key findings are that:

- Nutrition is everything; meeting the correct nutritional level required by the ewe is essential and drives the whole system. Increasing condition score of a lambing ewe from 2.2 to 3.2 equates to approximately 10% increase in single lamb survival.
- Increase the birthweight of lambs. This is the number one factor influencing lamb survival. A strong, healthy lamb that is up and suckling within 15 minutes of being born has a 90-95% chance of still being alive 90 days later.
- Each extra kilogram of birth weight results, in an extra 3.2 kg of lamb at weaning.
- Profitable farms find a way to utilise the grass they grow, thus reducing the amount of supplementary feed required and increasing the bottom line profit.

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Foreword

Sheep! Some say that the only thing madder than sheep are the people who farm them. Personally I disagree. However, when faced with some of the associated challenges I sometimes wonder. With this sentiment in mind and the need to continue to increase the production and profitability of the sheep business at home and with the support and guidance of friends and family, I was inspired to apply for a Nuffield Scholarship. This Scholarship has opened my eyes and given me a level of optimism and a desire for improvement in the sheep industry, not only in Australia but globally. Sometimes this goal appears to fade when we are caught up in the day to day grind of the farming business.

I have managed a number of sheep operations, from merino to cross breeds and I genuinely believe that the Merino can be as profitable as any cross bred operation. The Merino can rear twin lambs and produce a productive fleece of high quality. However, to do this we need to achieve a higher lambing percentages and weaning rate. Currently the average Merino lamb marking percentage sits around 90% at home and 80% nationally. This is an area that can be improved; it is not a ceiling set by the animal, but a reflection on the management provided. By exploring the reproductive potential of sheep my intention is to become another voice encouraging the industry to do better.

Through further study I have focused on improving the entire period, from before joining through to weaning. This stage of the annual management cycle underpins overall farm profitability and places greater pressure on genetic gain.

During my travel I initially focused on how to reduce lamb mortality, however that does not paint the full picture, as it suggests I am only looking at lambing specifically. I was really looking into increasing lamb survival, which I believe takes into account all the actions leading up to:

- Conception
- The first 48 hours after birth
- Weaning management and strategies

Travel is key criteria for a Nuffield Scholar and over the past two years I visited 13 countries:

- **New Zealand:** Efficient grass users and very good record keepers. I was also very lucky to have the opportunity to sit in on two very passionate Australian sheep men in Jason Tromph and Darren Gordon putting a sales pitch for Life Time Ewe Management (LTEM) to a select room of some of New Zealand's top vets.
- **England:** I learnt how influential the breed societies are and the growing movement of producers away from the show ring to a more objective breeding approach and I saw the progress they have made over the last decade.
- **Wales:** I met the founder of Innovis, one of the most progressive and intensively recorded new sheep breeds. I also got to spend some time in a lambing shed to understand the work involved and the high survival outcomes.

- **Scotland:** I learnt here that with good management practices lambing outdoors in a harsh climate is possible, whilst maintaining good outcomes.
- **Ireland:** I met the creator of the Belcare breed who taught me about the importance of scientists and farmers working together.
- **Uruguay:** I saw firsthand how Australian sheep genetics were performing in a different environment. I also learnt that the *Lucilia cuprina* fly is present in Uruguay. However, it does not cause fly strike in the way it does in Australia. This also where I got to see foetal programming research work in action.

Acknowledgments

I would like to sincerely thank Nuffield Australia for putting their faith in me and selecting me as a Nuffield Scholar. I would also like to acknowledge and thank most sincerely Australian Wool Innovation for generously donating the funds to Nuffield Australia to make opportunities like a Nuffield Scholarship possible.

I would also like to thank Pat and Sarah Millear for their unwavering support of me through the Nuffield journey. I hope what I have learnt during my travel and study can be put into action to repay them for the generosity and understanding they have shown.

To all the people in the countries I travelled who gave up their time to help me gain a better understanding of their business and research: you have been amazing and I hope to remain in contact for the years to come and repay the generosity shown to me.

To the Nuffield Scholars who I can genuinely call friends and the scholars I have never met. You have all paved the way for me in opening up doors and keeping the dialogue within my industry and other industries going, challenging the status quo which isn't easy but hugely admirable and has inspired me to keep pushing on.

Finally, I wish to thank my darling wife Julia, who has supported me on all my adventures and encouraged me to challenge myself and do things I thought I probably couldn't achieve! While I was away she managed to juggle a baby, get a new job, deal with tragedy and look after our little farm. She continues to impress and inspire me.

Abbreviations

AWI, Australian Wool Innovation

CS, Body Condition Score

DM, Dry Matter

DMI, Dry Matter Intake

DSE, Dry Sheep Equivalent

DUP, Digestible Undergradable Protein

EBV, Estimated Breeding Value

FOO, Food On Offer

Ha., Hectare

INIA, National Institute of Agricultural Research

LTEM, Life Time Ewe Management

ME, Metabolisable Energy

SIL, Sheep Improvement Limited

UCD, University College Dublin

Objectives

The objective of this report is to investigate the best practice in sheep breeding systems from Australia and the world. It is also designed to assist sheep producers who are seeking to improve their lamb survival outcomes, in an easy to follow format. All this research and investigation has been viewed through the lens of a Merino producer.

The key objectives are as follows:

- How to achieve the best results with the breed of choice. What emphasis should be placed on breed selection and what are the ideal breed objectives?
- Maximising conception rates and how different breeds and management influence those rates. What are the key influencing factors and how can we adapt them to an Australian system?
- The role of nutrition pre and post lambing. How do we efficiently and effectively achieve a balance that will promote growth but won't break the bank? How do we best utilise our grass?
- Lamb survival. What are the key issues? Should we aim for large litter sizes or are we better served to focus on keeping what we already have alive? What can we learn from research outside of Australia and is there a place for indoor lambing systems?
- What new research or technology is available to assist in maximising the reproductive potential of sheep? Are simple things like discussion groups or structured courses delivering outcomes to producers as beneficial as managing the physical inputs?

Introduction

Perinatal lamb mortality represents a serious biological and economic problem to the sheep industry worldwide. It is defined as the death of lambs shortly before or during birth, or in the first 28 days of life. In Uruguay, Australia, New Zealand, South Africa and most other sheep producing countries, perinatal lamb deaths average 10 to 20%, with 80% to 90% of these occurring within the first 72 hours after birth. Despite marked improvement in ewe and lamb nutrition, management and health control, this high perinatal mortality rate does not appear to have changed significantly during the past decades and it remains an intractable problem. Moreover, current recommendations for increasing conception rates generally do not translate into an increase in weaning percentage, because of the higher mortality rate in twin-born lambs (Dutra, 2007).

There are currently 75.5 million sheep in Australia of which 40.3 million ewes are one year and older, as at 30 June 2013 (ABS, 2012-13). Annually the Australian sheep industry, both wool and meat, contributes 3.4 billion dollars to the Australian economy (ABARES, 2011). This is a significant contribution. However, with global competition and the ever-increasing cost of production, maximising the return on every dollar spent will not only help an individual's bottom line but contribute to the Australian economy.

One-way Australian sheep farmers can capitalise on their dollar invested is to maximise their reproductive rate. On average 30% of all lambs born will die prior to weaning (Lockwood, 2014). Jason Tromph at the 2012 Lambex conference in Bendigo quoted an annual lamb loss figure of 15 million Australia wide within 48 hours of birth. The annual economic loss to the sheep industry in Australia of poor lamb survival has been variously estimated between AU\$250 million and AU\$56 million (Brien, 2014). However, the news is not all bad. Results from the MLA and AWI wool and sheep meat survey illustrate that, since 2010-11, the national Merino and non-Merino marking rates have been consistently higher than throughout the previous decade (Thomas & Mathews, 2015); however, these survey results are coming off an historically low base.

What these numbers represent to the Australian sheep industry is an opportunity. Considerable impacts can be made on reducing lamb losses if some simple management changes are implemented. A recent example is the use of tall wheat grass in hedgerows, which decreased mortality in twin-born Merino and Crossbred lambs from 24% to 13% in south-western Victoria (McCaskill, 2010). However, despite the advantages to lamb survival being widely known for many years, effective measures of shelter have not yet been widely adopted by farmers (Hinch, 2014).

The challenge is to encourage the implementation of best practice in to an on farm situation. This is where farmer discussion groups and facilitated information exchange seminars are vital to the implantation of proven ideas and technology. Two examples of this are the Life Time Ewe Management course (LTEM) in Australia and the Better Farm Beef programme in Ireland.

LTEM has been delivered to more than 300 merino and cross bred producers across Australia. In Victoria LTEM participants improved the number of lambs weaned per hectare by 30%. This was achieved through a 15% increase in ewe stocking rate, a 50% reduction in ewe mortality and a 15% increase in weaning rates (Gordon, 2014). Similarly, the Better Beef programme in

Ireland aims to turn efficiency into profit, and over a three-year period the farms involved in the programme achieved a 125% increase in gross margins (McCarthy, 2015). He also went on to say that all the farmers that participated in this programme were not as busy after finishing as they were prior to the commencement of the course.

Traditionally the Merino breed has dominated the Australian sheep farming landscape. It has generally been part of a low input system with healthy returns from wool. The poor lambing outcomes were tolerable, as the wool produced could cover the cost of production and a focus on speedy genetic gains was not in the forefront of decision making. We are now in an era where farming techniques have advanced at a rate that mean low performing enterprises have been dropped in favour of higher returning, easy to manage ones. For the modern sheep producer to stay economically competitive, he needs to adopt new technology, but not forget about how important getting the basics right can be.

Chapter 1. Breeding objectives

A breeding objective defines how the entire sheep enterprise will look. This is the starting point for any producer. At this point the producer defines what they want to achieve from their sheep breed. Is the sheep going to produce fibre or meat or a combination of both? It is also the chance to quantify what it is they want to achieve and set some targets.

There also needs to be a balance between research best practice and the farmer's objectives. Both Tim Keedy and Seamus Hanrahan from Teagasc in Ireland believe it is reasonable to talk about genetics alone, but you have to marry genetics with nutrition as well, as one will not work without the other. Seamus Hanrahan, who is responsible for developing the Belcare breed, which is a composite designed to achieve high litter sizes or prolificacy, said that you must have a clear breeding objective and stay focused on it when thinking about breeding. He also went on to say that while some genes are performing well in other areas they may not express themselves positively in your environment (Hanrahan, 2015).

There is little point in chasing high prolificacy traits or superior lamb growth rates as selection criteria, if your management or feeding system is not capable of achieving the genetic potential. The breed selection requires a level of planning similar to that of the whole farm. For example, the more arid zones of Australia are far better suited to an extensive Merino system where the wool cut helps make up for the shortfall in lambs that can arise due to lower rainfall and inadequate nutrition.

Another consideration when setting the breeding objective is the breed society. How much influence should a breed society have on an individual's breeding objective? For commercial producers this question is probably not binding, whereas for the stud breeder of a specific breed, the society and show ring is far more of a focus. Two examples of breeds where this is very important are the Texel and Beltex breeds, who aim for a carcass shaped to achieve the highest grade on the EUROPE meat grading scale in the EU. The implications of this in a practical sense can be quite onerous for the breeder, as this results in a high percentage of assisted births. Dewi Jones from Innovis in Wales put it best when he said that we need to focus less on breeding for one another and more on what are important commercial traits (Jones, 2015).

Chapter 2. More lambs, more profit

The two most common pathologies causing lamb death are dystocia/birth injury and the starvation/mis-mothering/exposure complex, with losses attributable to infections, primary predation and specific nutritional deficiencies. Lethal congenital malformations are generally less important. Risk factors for lamb mortality include the nutrition and breed of the flock, the age and behaviour of the dam and the sex, birth weight and birth rank of the lamb, among others (Dutra, 2007).

If we are going to wean more lambs for a more profitable business, there are a few very critical factors we need to take into consideration. Trevor Cook a farm consultant from New Zealand, explained his key points of influence (Cook, 2015). These are the critical times during the year producers can have the maximum impact on lamb survival:

- Body Condition Scoring (CS) at weaning and prioritising feed for the thinnest ewes.
- Six weeks before joining ewes must be in good condition (above CS 3), this allows enough time to reach the target CS.
- The ten days before joining are the first part of what Trevor calls the “20 golden days” which also includes the first ten days of joining. Maintaining the correct high value nutrition during this period, will have the biggest effect on the outcome of mating and the profitability of the business.
- Pregnancy scanning at about day 70. Condition scoring at this time will identify poor CS ewes and give time to get them back up to the target CS of 3+. It is also important to note that the person most skilled in CS identification should be the one pushing the ewes into the scanning crate to correctly identify and mark light ewes.
- In the final 35 days before lambing the foetus grows rapidly and the ewe’s udder gets ready to produce milk. A strong, healthy lamb that is up and suckling within 15 minutes of being born has a 90-95% chance of still being alive 90 days later. At this stage of pregnancy, the ewe requires the highest quality grass available (Cook, 2015).

2.1. Lamb Birth weight

Lamb birth weight is the absolute key factor in determining survival (Vipond, 2015). He also went on to explain that light lambs will lose body heat at a greater rate when compared to heavier lambs, due to the lower volume to body weight ratio. This again relates to Trevor Cook's earlier statement, that lambs that stand and suckle in the first 90 minutes have a greater chance of survival.

The optimum birth weight for each size of litter has been defined as follows (Keedy, 2015):

- Single = 6kg
- Twin = 5kg
- Triplet = 4.5kg

Figure 1 below confirms Tim Keedy's work, which is research from the Australian Lifetime Wool program. It illustrates clearly the importance of lamb birth weight.

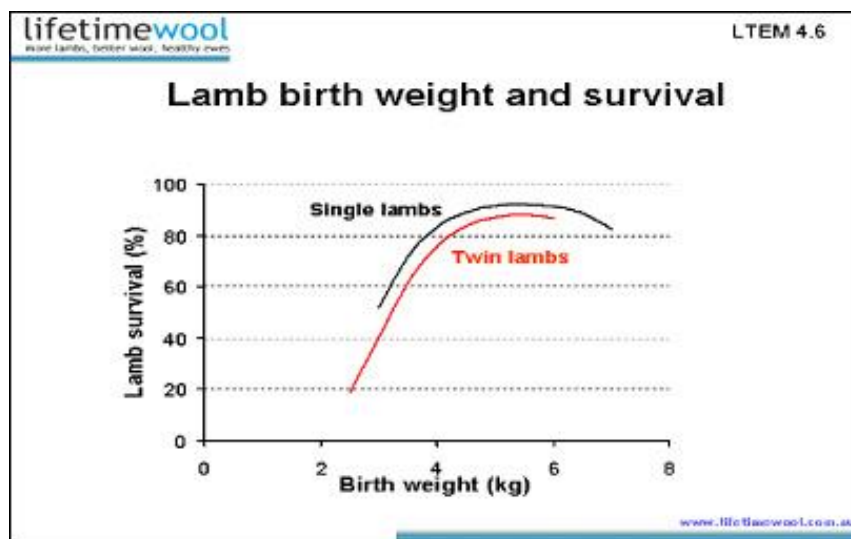


Figure 1. Importance of lamb birth weight. Source, Lifetime Wool.

Lamb birth weight is the greatest contributor to lamb survival; however, even when birth weights are optimised, lamb survival to weaning rarely exceeds 90% for singles, 75% for twins and 60% for triplets Oldham et al. (2011), Hinch (2014) and Brien (2014). Lambs that died after 48 hours had significantly lower birth weights than those that survived (Oldham, C.M. et al.). A higher birth weight will contribute to the lamb's ability to handle any chill effects.

Mid-pregnancy shearing can also have a positive effect on lamb birth weight and subsequent survival. According to one source (Cam, 2004), shearing ewes on day 100 of their pregnancy enhances lamb birth weight and weaning weight, and increases subsequent milk yield, either directly or indirectly because of increased lamb weight and behaviour, and hence a higher lamb survival can be obtained at weaning.

Each extra kilogram of birth weight results, at weaning, in an extra 3.2 kg of lamb (Vipond, 2015).

2.2 Nutrition & Pasture Utilisation

Grass is one third of the cost of concentrate (Blance, 2015).

One of the biggest lessons learnt while travelling was the importance of getting the nutrition right and how critical pasture is in economically meeting those nutritional goals. When comparing the Australian ideal pasture levels and quality with those of New Zealand, UK and Ireland, it stands out how the art of good pasture management in much of Australia's sheep producing areas has room for improvement. High levels of waste are prevalent in Australia. Waste can be defined by sheep that are carrying excess body condition, over and above what is considered an economic body condition and also letting pasture levels grow beyond the highest feed quality before sheep are grazing them. It could also be defined as overgrazing, which is not allowing correct time for the pastures to recover. Mulvaney (2014) stated that New Zealand farmers would find the Australian optimum condition score profile wasteful, as he believes New Zealand farmers would not waste enough feed on offer (FOO) for ewes to be above CS3.

By utilising grass that we grow, we are reducing the need for a heavy supplementation requirement that is quite common practice in Australia. While we cannot expect to have green grass in summer we can certainly utilise the high quality pasture in late winter and early spring a lot better.

Recent benchmarking data from (Francis, 2016) suggests that the top 20% of Australian sheep producers were utilising 50 to 60% of pasture produced. Whether this is through better stocking rates and grazing plans i.e. rotational grazing or cutting silage to utilise the excess production. It can also be due to minimising the overgrazing of paddocks, which can lead to a loss of preferred or sown pasture species and open the ground up to less desirable annual species of lower quality.

Tommy Bolland from University College Dublin (UCD) in Ireland, found that when ewes were fed concentrate for the first six weeks of pregnancy, it directly affected grass intake by pushing it down creating a direct substitution effect (Bolland, 2015). He also went on to say this did not vary the overall dry matter (DM) intake.

Profitability of livestock enterprises is primarily addressed by increasing pasture production, pasture utilisation (primarily through stocking rate), livestock performance and limiting the amount of supplementary feeding. The aim is to produce greater wool and meat per hectare without increasing financial and production risk due to climate variation or risk to the environment (Ever Graze, 2013).

Pasture utilisation and its relationship to farm profit

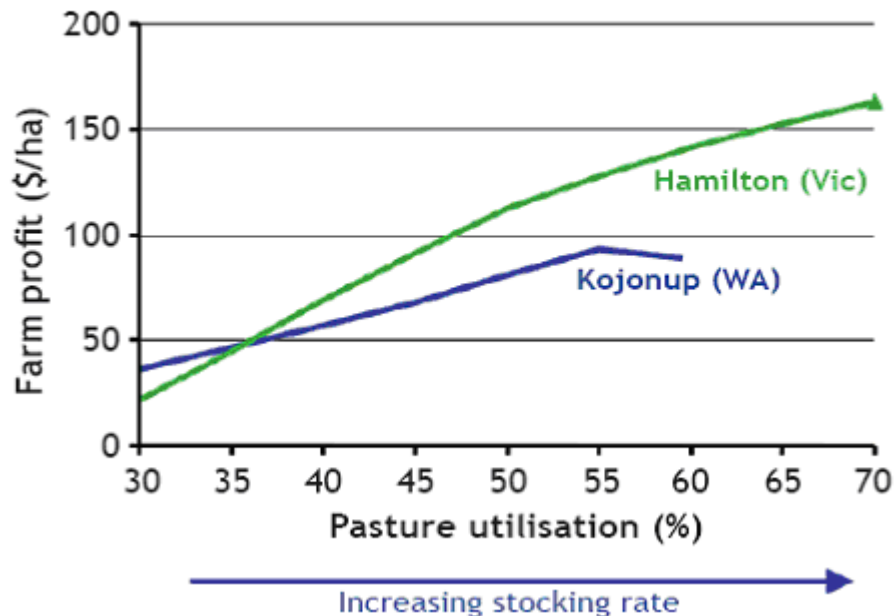


Figure 2: Pasture Utilisation and its relationship to farm profit. Source LifeTime Wool.

Figure 2 above further explains the importance of pasture utilisation, in relationship to profitability. Another useful point the graph makes is how variable the Australian climate can be, when Hamilton in western Victoria, with an average rainfall of 670 mm and a longer growing season is compared with Kojonup in south west Western Australia at 530mm. Figure 2 also shows how important carry over feed and ground cover is in the shorter growing season.

In Uruguay there is some very interesting work conducted by a student of the Universidad De La Republica in Cerro Largo, under the guidance of Raquel Prerez (Prerez, 2015). This group discovered that the foetus developed different organs at different stages. Interestingly the foetuses that came from the ewes that only received 10% of their nutritional requirement had the same weight for their heart, brain and central nervous system. However, all other major organs, like kidney and liver, were a considerable percentage lighter. Their conclusion is that poor nutrition would lead to these animals having a lifetime of under-performance and diseases of the major organs, meaning poor nutrition has a lifelong effect.

DUP (digestible undegradable protein) has recently become more of a focus as an important feed source for ewes in late pregnancy, e.g. soya bean meal. This is a form of protein that is not easily broken down on the way through the rumen, and more readily available further down the digestive tract, in comparison to some proteins that are lost to the animal before they have had a chance to digest them. In the United Kingdom there is an increasing realisation that it is not energy the ewe is short of in late pregnancy on good forage but protein. Protein levels are usually fine in lowland flocks on good forages fed ad-lib, but the near-birth rise in faecal egg counts is a good indicator of insufficient protein to maintain immunity (Vipond J. , 2015). He also stated that feeding grain supplements along with good forage to pick up a metabolisable energy (ME) deficit means ewes will get fatter, have more lambing difficulties and are at higher risk of acidosis-induced pregnancy toxemia.

2.3 Condition Scoring

Condition scoring (CS) is the score card that lets us know how well the ewes are performing, according to the available nutrition. Figure 3 below highlights the importance of CS. We can see that ewes in CS 2.2 are considered to be in very poor condition hence the poor lamb survival response, conversely a ewe in CS 3 is considered to be in good condition and the lamb survival results are better.

FARMER CASE STUDY - EWE CONDITION SCORE AT LAMBING AND LAMB SURVIVAL

	CS at lambing	Survival of singles (%)	Number of lambs, single	% Difference	Survival of twins (%)	Number of lambs Twin	% Difference
Western Victoria (4sites)	2.2	74	74	-	38	76	-
	3.1	86	86	14	56	112	32
All States (16 sites)	2.2	83	83	-	57	114	-
	3.0	90	90	8	67	134	15

Assume all ewes pregnant at the point of lambing.

Figure 3: Importance of condition scoring, adapted from lifetime wool.

The ability to accurately condition score is the cheapest management skill available, and one which can have the biggest impact on farm profitability. Trevor Cook stated, “eye metering” is not good enough. You will be missing at least 25 to 50% of low condition scores if you are using your eye (Rural News, 2013). He also went on to suggest that by lowering the number of ewes below condition score 3 from 15% to 5%, can produce a major production response. By allocating feed to lift light ewes, the return will be much more than anything else you can do on the farm. The figure below gives a good explanation on how to condition score.






	Backbone The bones form a sharp narrow ridge. Each vertebra can be easily felt as a bone under the skin. There is only a very small eye muscle. The sheep is quite thin (virtually unsaleable)	Short Ribs The ends of the short ribs are very obvious. It is easy to feel the squarish shape of the ends. Using fingers spread 1cm apart, it feels like the fingernail under the skin with practically no covering
	Backbone The bones form a narrow ridge but the points are rounded with muscle. It is easy to press between each bone. There is a reasonable eye muscle. Store condition- ideal for wethers and lean meat.	Short Ribs The ends of the short ribs are rounded but it is easy to press between them. Using fingers spread 0.5cms apart, the ends feel rounded like finger ends. They are covered with flesh but it is easy to press under and between them.
	Backbone The vertebrae are only slightly elevated above a full eye muscle. It is possible to feel each rounded bone but not to press between them. (Forward store condition ideal for most lamb markets now. No excess fat).	Short Ribs The ends of short ribs are well rounded and filled in with muscle. Using 4 fingers pressed tightly together, it is possible to feel the rounded ends but not between them. They are well covered and filled in with muscle.
	Backbone It is possible to feel most vertebrae with pressure. The back bone is a smooth slightly raised ridge above full eye muscles and the skin floats over it	Short Ribs It is only possible to feel or sense one or two short ribs and only possible to press under them with difficulty. It feels like the side of the palm, where maybe one end can just be sensed.
	Backbone The spine may only be felt (if at all) by pressing down firmly between the fat covered eye muscles. A bustle of fat may appear over the tail (wasteful and uneconomic).	Short Ribs It is virtually impossible to feel under the ends as the triangle formed by the long ribs and hip bone is filled with meat and fat. The short rib ends cannot be felt

Figure 4: How to condition score, (source: Lifetime Wool)

In discussing the importance of condition, Georgette Ballechero who is a sheep researcher for INIA, in Uruguay, pointed out that ewes in poorer condition had slower births. This in turn caused spinal and or brain damage to new lambs due to the ewes struggling to push the lamb out. Lesions in the central nervous system can explain most deaths at birth and within six days of birth. The lesions were primarily caused by the physical trauma caused during the prolonged birth event. (Dutra, 2007).

Finally, on discussing nutrition, *fit not fat* is a common theme amongst researchers and consultants. Fat ewe losses can be up to 10% on a set stocking system, (Young, 2014). The fatter the ewe the harder it is to keep her in a positive energy balance. By having ewes too fat there is less tolerance in balancing the energy requirement. There is also a greater risk of increasing levels of a dangerous toxin associated with cessation of eating called, beta-hydroxybutyrate, which result in dropping energy and body condition. The effect this can have is to cause “dopey” lambs at birth, due to pregnancy toxemia, in severe cases resulting in the death of the ewe (Cook, 2015).

When we focus on particular additional nutritional requirements of the Merino ewe near birth, her foetus is growing a large amount of secondary finer wool fibres in the last week of gestation, meaning the foetus is drawing out large amounts of sulphur- containing amino acids (Vipond, 2015). The ewe also has a large protein requirement which increases by 100% for each foetus.

The effects of early and late-pregnancy nutrition on progeny wool production and quality are additive and permanent throughout the animal's lifetime. They cannot be fully compensated for by improved nutrition after birth (LifeTime Wool, 2011), meaning that:

- An increase of +1 CS equals +0.2 kg clean fleece weight and reduction of 0.4 micron.
- Ewes that lose 0.5 CS during early pregnancy and then gain 0.5 CS to lambing, produce progeny that will cut the same amount and fibre diameter of wool as those from ewes that maintain CS throughout pregnancy
- Good managers will be able to capitalise on the feed saving available, by either reducing supplementary feed or deferring grazing to increase FOO levels on lambing paddocks.

2.4 Pregnancy Scanning

The next most important area to concentrate on is pregnancy scanning, which is the process of using an ultra-sound device to scan the ewe's uterus to ascertain her pregnancy status. By pregnancy scanning from day 70 to 90 of gestation, subsequent management decisions can be made when allocating the best food on offer (FOO). Interestingly, once scanning percentages start to exceed 180%, the amount of triplets increased dramatically and the number of single-bearing ewes dropped. This is a management issue for most farmers as triplet management is one of the biggest challenges for even the best managers of Merino ewes.

The benefits of scanning ewes for pregnancy status and litter size were calculated to be \$7,800 for a typical farm in western Victoria. The optimum management was to feed twin bearing ewes to gain extra condition from scanning, so they were ~0.3 of a CS fatter than single ewes by lambing (Young, 2012).

Young, a sheep consultant from New Zealand, also pointed out the traditional uses of pregnancy scanning, which are:

- Identifying dry ewes (non-pregnant ewes)
- Targeted feeding of singles and multiples
- Selecting lambing paddocks
- Targeting stocking rates

He also went on to explain that scanning can also offer some more technical information that suits high performance flocks. For example, foetal aging allows the possibility of a split lambing, in which ewes can be moved onto appropriate levels of pasture to suit specific lambing dates. It also means you can preserve pasture. The other advantage means ewes need not be set stocked for too long, which can create dystocia issues for single bearing ewes that have had too much feed.

2.5 Pest & disease.

Some of the major pests and diseases affecting pregnant ewes are:

1. **Campylobacter:** This is a bacterium that infects ewes in late pregnancy and can result in significant loss of lambs. Campylobacter has been prevalent in sheep flocks in Australia for some time and can be attributed as the leading cause of diagnosed sheep abortion. Recently in my home district, we experienced an abortion storm in Merino maiden ewes. That year the marking percentage was approximately 45%. After researching campylobacter, we tested our flock for the disease. It was found to be present. A vaccine was administered to the maiden ewes with a commercially available vaccine and found the following year the lamb marking percentage rose to 89%. New Zealand and the UK routinely vaccinate against abortion causing diseases where as in Australia it is far less common.

2. **Pregnancy toxaemia:** Thin ewes or very over-conditioned ewes and ewes carrying multiple pregnancies are more likely to develop pregnancy toxaemia (ketosis). Pregnancy toxaemia is a metabolic disorder characterized by hypoglycemia and hyperketonemia resulting from incapacity of the ewes to maintain adequate energy balance (usually in the last 5-6 weeks) (Ali Olfati, 2013).

3. **Footrot:** Without exception this is one of the number one sheep diseases around the world that is holding production back and causing stress on pregnant and lactating ewes which ultimately results in poor lambing percentages.

Other diseases that can contribute to production losses in lambs that are relatively unknown are things like pleurisy which could be costing the equivalent of 22 days' growth in lambs (Hickford, 2014).

2.6 Shelter & paddock selection

Providing adequate shelter is a basic step that can be implemented and which can markedly improve lamb survival. Shelter is particularly useful in reducing the wind-chill factor, which combined with wet conditions, can cause large losses in new born lambs. The Ever Graze trial site at Hamilton conducted research on the effect and potential benefits of planting hedge rows to reduce lamb mortality. For lambs of average birth weight, regardless of whether they were born as singles, twins or triplets, survival at the Hamilton site increased by 30% when grass hedgerows were used for shelter (Ever Graze, 2013)

While implementing shelter can have a big impact it also comes at a cost of time and money to establish. At the EverGraze Hamilton Proof Site in 2009, providing shelter to Merino-born twin lambs increased profits by approximately \$5 per ewe mated (not just those carrying twins). This would be sufficient to pay for the establishment of hedges (at \$250/ha) in three years (Ever Graze, 2013).

In south-eastern Australia, the greatest number of flocks lamb between June and September. During these months, it can be cold, wet and windy resulting in a high proportion of days experiencing bad chill in high risk areas (Figure 5). Chill index is calculated from wind, rain and temperature. A bad chill day is one where the chill index exceeds 1000 kJ/m²/h and the risk of lamb mortality increases significantly.

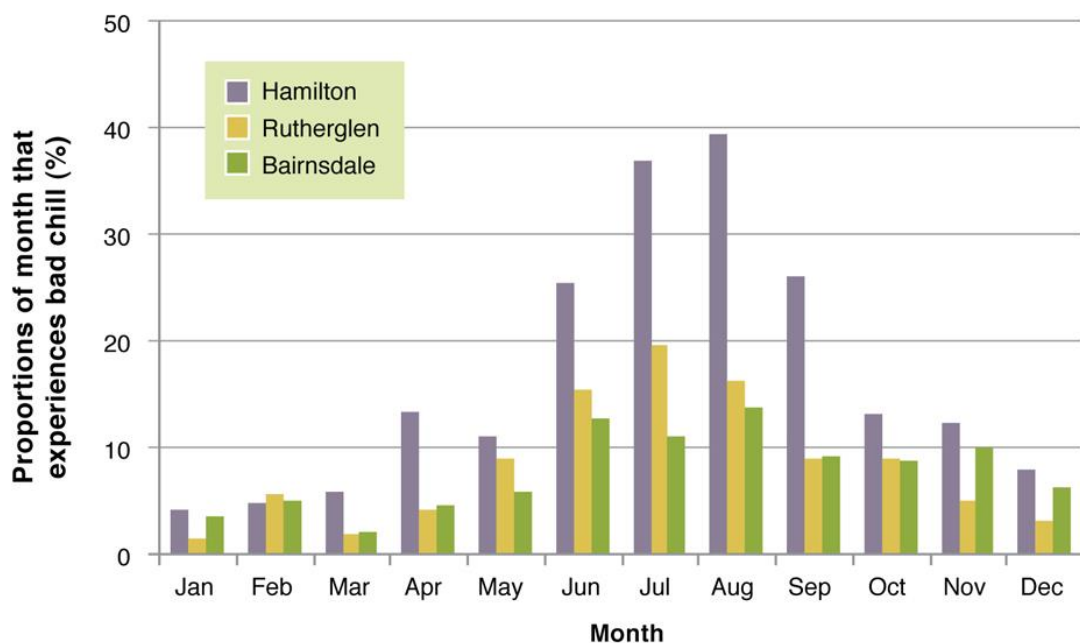


Figure 5: Proportion of each month that experiences bad chill. (Source EverGraze)

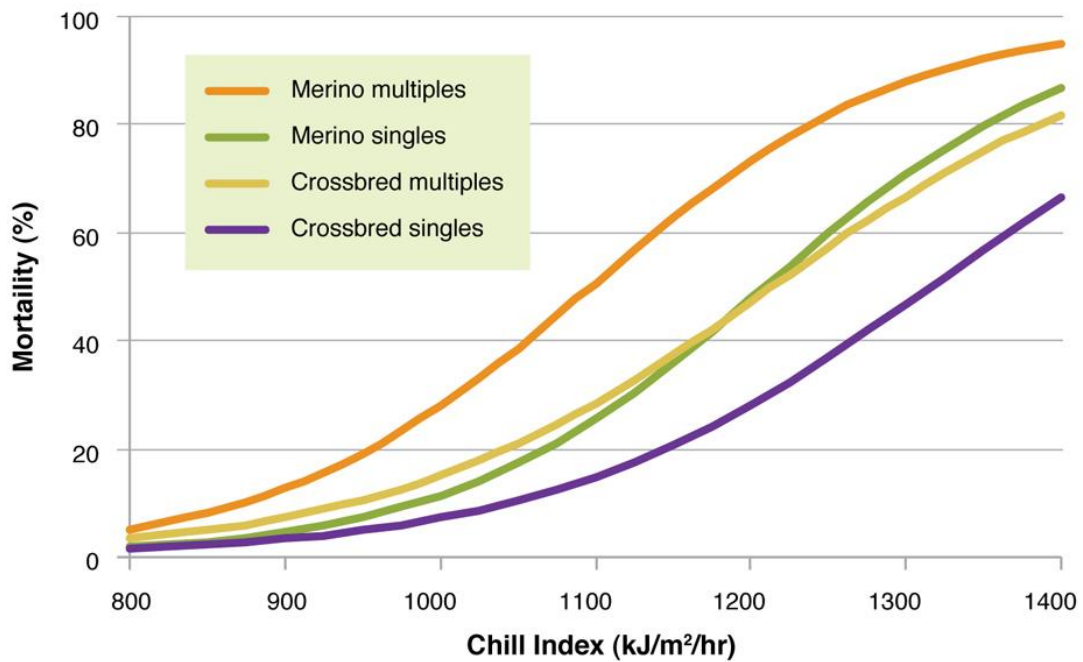


Figure 6: Relationship between wind chill index (kJ/m²/hr) and the mortality of single and twin lambs born to Merino ewes and cross bred ewes (adapted from Donnelly 1984)

The figures above clearly demonstrate the need to reduce the wind chill factor. Tree plantations have also been successfully used as well, for example providing shelter in the form of Cypress hedges reduced mortality in single lambs in the first 48 hours to 6% compared to 19% for lambs born in unsheltered paddocks (Elliott, 2012). Vipond, (2015) explained that prostrate lambs will lose body heat four times faster to the ground compared to when they are standing. He also went on to explain that smaller lambs have a larger surface area to body volume in comparison to larger lambs, so they are more likely to succumb to cold weather.

Another other example of specific outdoor shelter plantings was seen in Uruguay. Eucalypts from Australia and South Africa are used not only for shelter but timber as well. Another example was a trial using *Pennisetum purpureum schum.*, which looks like sugar cane, at the INIA research farm in Colonia Uruguay.



Figure 7: An established plantation in Colonia, Uruguay, to help provide shelter for lambing.

It should be noted that the optimum time for lambing in regards to stocking rate for western Victoria is around late August. Every week earlier will result in a reduction of 1 dse/ha (Young, 2012). This is due mostly to the lack of available feed at peak demand times, with contributing factors from cold weather coupled with high wind chill factors.

When it comes to paddock selection the key considerations are:

- Stocking density. How many sheep per hectare not DSE per ha.
- The available FOO.
- The shape and layout of the paddock, corners, hills or obstacles.
- The time of the year lambing is to take place also has a bearing on which paddocks are suitable.

When discussing paddock selection with Peter Young he suggested no set paddock size as that depends on the topography and paddock shape a lot. Based on some work with a Merino client he has lambing on flat paddocks, there was a strong correlation between lamb wastage and paddock size. Paddocks over 20 hectares all had losses in the double figures (13%) and smaller paddocks the losses were in single figures (8.4%). The larger the paddock the higher the risk of mis-mothering in adverse weather (Young, 2014). He also went on to say that he found mismothering occurs at stocking rates higher than 8 to 8.5 sheep to the hectare; higher stocking rates mean greater ewe density and create confusion around the birth site. This is pertinent as the merino has a tendency to choose a birth sites very close to one another.

There is certainly a mob size effect pertaining to the Merino breed, as the lamb nursery seems to be in the one spot, whereas Romney ewes will spread evenly over an entire paddock (Ferguson, 2014).

One way of ensuring the optimum paddock size is the use of paddock subdivision using a simple three-wire electric system. This technology has been widely used in New Zealand for a number of years. It is easy to setup and maintain. There is certainly more of this happening in the UK as producers look to an outdoor lambing system.

2.7 Weaning

Weaning is a very important time for ewe and lamb. This is the time lightweight ewes can be condition scored into two major categories; sub-score three's and plus-score three's. Condition score three is recognised as the optimal economic condition score profile particularly prior to joining and lambing, (LifeTime Wool, 2011). This is also an important time for the weaners as well as the weaners can be drafted according to weight, possibly three ways; e.g. 18kg live weight, 18 - 22 kg and 22 kg and over. The sub 18kg lambs are the lambs most at risk of poor performance and death.

After the weaners are older than 56 days, ewe lactation performance has no influence on lamb weaning weight (Cook, 2015). He went on to say that recent research conducted by Massey found that a maximum of 30% of the lamb's weight at weaning is driven by ewe lactation. He also stated that lambs could be weaned by 80 to 90 days from lambing rather than the traditional 120 days, which is a traditional time period for meat breeds. This work is particularly relevant for the Australian Merino producer as average rainfalls appear to be in decline. This would allow managers to utilise high value pastures for weaners which will allow them to consume the equivalent of 15 MJ/day.

2.8 Technology, genetics & Estimated Breeding Values (EBV's)

Computer modelling software linked to external consulting organisations are in regular use in New Zealand. These computer programs utilise data around pasture growth and make predictions on how the season could possibly go based on previous data entered. This gives producers a really solid understanding of how much pasture they have on hand and how much they could grow and gives them the option to buy stock in, make silage or hay or sell stock off.

Electronic Identification (EID), in the form of ear tags, has been available for some time and widely used in the Australian cattle industry. The take up in the in New Zealand, UK and Australian sheep industry has been slow, but productive. It is used in conjunction with other programs to group animals and to match progeny to dams using panel readers set up in paddocks. A panel reading system relies on animals with EID to walk past a panel sensor that matches the EID to a specific animal. It is also used to record growth rates of lambs. Abattoirs are incorporating EIDs into their systems which track the lamb through the whole slaughter process, which gives the producers individual animal feedback and it also adds a higher level of accountability.

One of the key management implications of utilising EID technology in a ewe flock is to identify top producing or efficient ewes in the flock. These ewes are efficient in terms of lambs weaned and wool produced.

Innovis are industry leaders in the UK when it comes to the use of technology and genetics. They were using full body CT scans to analyse all their stud animal's carcass and reproductive characteristics. They also DNA test all lambs dead and alive for parentage. Other DNA tests, available mostly through New Zealand, are the footrot susceptibility test and the cold tolerance gene marker test which is relatively new.

In regards to estimated breeding values (EBV's), there has been steady growth in the uptake of different systems around the world; however, it is coming from a low base. Sheep Ireland have the EuroStar which started in 2009 with 70 producers, a number which rose to 600 in 2015 (McDermotts, 2015). New Zealand have the Sheep Improvement Limited (SIL), Australia has Merino Select and Lamb Plan, UK has Signet and Uruguay have also been using breeding values in their Merino's.

An example of where using breeding values to select for certain traits can have a positive effect was explained by (Ferguson, 2014). He stated that increasing the eye muscle fat depth in a Merino sire by 1mm can halve the weaner death rate. In relation to the effect of breeding values, he went on to state that selecting for fleece weights can have an antagonistic effect on birth weight. In Scotland Cathy Dwyer from SRUC explained that they have developed an EBV based around lamb vigour and the time it takes for the lamb to stand and suckle. This trait quite heritable at 20%, however it was very labour intensive to record as someone had to be at every birth; it would possibly only be suitable for studs.

Chapter 3. Lessons from around the world

Amongst some of the major sheep producing countries there are a lot of similarities and some very obvious differences. For example, the amount of lambing indoors in the UK was high. This was mostly aimed at reducing the losses to the cold weather and partly to do with having lambs grown out to gain the highest price in the market. The other obvious difference between the UK and Australia is the single farm payment which is a form of subsidy, which certainly helps in justifying high capital or labour intensive operations that would, most probably, be cost prohibitive in Australia or New Zealand.

3.1 New Zealand

Key sheep facts:

- 30 million sheep, of which 20 million are ewes for the 2012-13 period, down from 55 million sheep back in 1995.
- Romney make up nearly 50% of the sheep breed, with Merino's around 5%.
- The average farm in New Zealand, in the 2012–13 period, derives 10% of its income from wool and 45% from sheep (meat sales) (Beef + Lamb New Zealand, 2014).
- Lamb wastage is typically quoted at approximately 20%.
- Foot rot is a major production and health issue for New Zealand sheep.

Sheep in New Zealand have been pushed further into the marginal country as dairy conversions have taken place on much of the higher production value country. This has been one of the key drivers for the declining number of sheep in New Zealand. However interestingly lamb production has remained reasonably steady due to gains in ewe efficiency and lamb survival (McFarlane, 2014).

Grass management and the need to capture the potential productivity is critical. As is the case with the UK and Ireland, sourcing affordable supplement like cereal grain is cost prohibitive, so grass growth and capture is critical to the success of grass farmers. In New Zealand there is a big focus on cents/kg dry matter produced. How the pasture is grazed has a big bearing on utilisation and profitability. The very best set stock graziers can only use 65% of the pasture, whereas farmers rotationally grazing were able to use 85%, which gave them the potential to double the gross margin per hectare (Cook, 2015).

Cheap and easy to erect electric fence systems were used all over New Zealand, this gives the farmers great flexibility to adjust stocking rates as the season dictates.



Figure 8: Simple three wire electric fence on Sandy Chaffeys property, Blenheim, New Zealand

Stock Care is a very similar program to LTEM. As an industry the aim is to bring lamb wastage down to 17% in Merinos and 12% in cross bred. New Zealand farmers lose around 17% of their lambs to dystocia.

Farmers in New Zealand were split between zero intervention on ewes that lambed in the high and hill country to farmers that had a twice daily lambing beat, where key pieces of information were recorded in regards to weather on the day, lamb losses, what the losses were attributed to, including any other trouble that may have occurred with individual ewes to the mob and the paddocks in general. Merinos in New Zealand are typically small-framed, fine wool, Saxon type around 16 micron. They are typically run in the high country, with lower rainfall, poorer pastures and harsher winters. Typical lamb marking percentages in these circumstances are around 70%.

Even though New Zealand is leading the way in many areas of sheep production, for many producers they still lamb at a time that will ensure their lambs will be ready for a specific market e.g. the Chilled Christmas UK lamb market, rather aiming for the best lamb survival outcomes.

3.2 UK: England, Wales and Scotland

Key sheep facts:

- 32 million sheep with 15.5 million breeding ewes (EBLEX, 2014)
- No real change in lambing percentage in twenty years at around 1.2 lambs per ewe.

Lambing percentage and stocking rate account for most of the variation in gross margin between farms and hence potential profitability. Increasing production from one to two lambs per year reduces the energy requirement per kilo of carcass produced by around 40%. Clearly this contributes to a reduction in costs.

While national lambing percentages have not moved significantly for some time, the aim of the UK sheep farmer is to target one kilo of lamb sold or retained per kilo of ewe mated; for example, a Mule (meat breed ewe) weighing 75 kg produces on average 1.7 lambs weighing 45kg each. (Vipond J. , 2015).

Winter management of stock is very similar to late summer/early autumn management here in Australia. In the UK & Ireland pastures can be ruined over winter through bogging and overgrazing, resulting in long term damage of the paddocks and reduced pasture quality and composition. This means a lot of stock are either grazed in a rotation over winter on a specifically grown feed type, or typically put indoors or on containment feed pads, where all the fodder (typically silage) and concentrates (typically soya meal) are carted in. This management is mirrored in Australia, particularly in the higher rainfall zones.

3.3 Ireland

Key sheep facts:

- Average flock size < 100 ewes.
- National lambing is around 1.2 to 1.3 lambs per ewe for the last twenty years.
- Stocking rate falling from 9 to 9.5 to 7 to 7.5 ewes to the ha, mostly due to the average age of farmers increasing (Keedy, 2015).

In at 10 and out at 4 (McCarthy, 2015): this is what Justin McCarthy explained when giving a good rule of thumb for pasture management, move cattle in on 10cm of pasture height and remove them at 4cm pasture height. While this is a cattle principle it is still very applicable to sheep in terms of setting a bench mark around rotational timing. This allows the pasture to recover quickly and will ensure good longevity of the pasture. Grass management and growing and conserving fodder were very important issues to Irish farmers, as concentrate and other feeds feed were hard to procure and quite costly.

When it came to the management of sheep and best practice it really was breed society vs. researchers and genetics. Sheep Ireland have been working on establishing an estimated breeding value system called Eurostar, which is very similar to Lamb Plan or Merino Select. As an example if a sheep EBV is 90% accurate it translates to approximately 81% reliability. This gap will narrow over time as more progeny from a certain sire are tested. Eurostar started in 2009 with 70 farmers, growing to 600 in 2015, however there is a long way to go with a lot of sheep producers very sceptical about the objective measurement of sheep and the accuracy of the data that is going into the system.

3.4 Uruguay

Key sheep facts:

- Eight million sheep flock.
- Sheep's wool contributes \$350 million dollars to the national economy.
- Uruguay is currently under quarantine export restrictions on certain cuts of meat due to foot and mouth issues.

Sheep numbers are falling, meaning there is less focus on the sheep industry and the critical mass required to keep different markets viable is becoming an issue. Wool contributes around \$350 million dollars to the economy. There are approximately 15,000 sheep farmers with estimates of only 15% with some formal training. Labour costs are quite high and increasing.

Three research centres visited were; National Agricultural Research Institute (INIA), Uruguayan Wool Secretariat (SUL), & the University of the Republic. INIA and SUL are both privately and government funded. The private funding comes from grower levies.

When Australia experiences an El Nino, South American countries experience an increase in rainfall, and recently they have experienced far wetter than average seasons which is placing huge pressure on sheep breeders in the areas of the country which are experiencing more rainfall.

The average age of farmers is increasing, like the rest of the world. This is having an impact on the sheep industry, as younger farmers are tending to move away from sheep enterprises. The next major threat is the average age of the farmers and the lack of willingness from the younger generation to take up sheep farming. This is partly due to the ever increasing soya crop, which up until recently has been providing farmers with a better return per hectare than sheep.

What Uruguayan farmers are aiming to achieve with their wool sheep breed is very similar to Australia and New Zealand. They are aiming to bring micron in wool breeds down and increase wool cuts per head. Interestingly Uruguayan wool producers can become accredited to test their own wool on farm which allows the wool to be directly marketed from the farm to the processor, unlike the Australian system of off-farm testing and selling through an open cry auction system.

As in other countries there is a move away from wool breeds to a composite or synthetic as the Uruguayans call them. Sheep are being pushed further into the marginal country as soya crops, blue gum plantations and other higher value enterprises take over. There are a lot of small land holdings in Uruguay which presents an opportunity for sheep industry to grow as cropping or cattle are not suited.

Uruguay has a lot of Australian genetics in its sheep flock. The biggest threats to the sheep industry in Uruguay in production terms are the barbers pole worm, the screw worm fly and foot rot. A lot of these problems are being exacerbated due to the increasing rainfall certain areas of Uruguay have been receiving. Interestingly the screw worm fly has been bred out of existence, however as it lives over the borders of Argentina and Brazil it requires a coordinated culling strategy between all three countries which has proved too difficult, so the fly has come back into Uruguay.

There are a lot of improved pastures in Uruguay with white clover and Lotus or Birdsfoot trefoil quite prominent across the country. Cancers on the exposed skin of sheep has also become a problem, which is forcing a move away from certain breeds.

The attributable deaths of new born lambs in Uruguay are very similar to that found in Australia. Pregnancy rates ewes are averaging around 90%. Pregnancy testing is not common place with sheep farmers in Uruguay.

Conclusion

There are many different breeds of sheep around the world, bred to suit a specific climate or resource need. Each one of these breeds is the best, according to the breeder. The challenge is to pick the breed with the attributes and genes that will express themselves in a positive way in any chosen environment. This is why it is important for Merino producers to actively pursue animals that have been bred using objective measurements. This will ensure genetic gain and a level of accuracy in breeding; it also gets the breeder to their objective quicker.

As sheep producers we need to know our reproductive wastage and its cause before we can really implement any meaningful strategy. By understanding and addressing the nutritional requirements of our ewes we stand the best chance of capturing more of the potential lambing percentage and furthermore the genetics on offer. There is no silver bullet to increasing lamb survival; it comes down to understanding the problems and acting on them. Understanding how to correctly condition score your animal and measure, manage and utilise the pasture in front of it will dramatically increase lamb marking percentages for a vast number of sheep producers.

If we as producers want to achieve the full benefit of what our ewes can offer, we need to utilise the management tools that are already in use. One of these tools is pregnancy testing. The information generated from a simple pregnancy test can have huge impact on the survival outcomes of the lambs.

For producers looking to capture the small, but additive gains available, there are a myriad of options available as management and technology has progressed. One example is the DNA parentage test which has made huge advancements for many sheep studs in the knowledge of their flock and great gains in the stud's genetics.

Sheep around the world are being pushed further to the margins in favor of higher returning enterprises from the same country. Demand for dairy and high-value crops are far more favorable in terms of gross margin, meaning producers who have made the decision to continue sheep production have had to become more efficient and ruthless in their selection practices as it is no longer viable to have sheep that do not pull their weight economically. These producers have also recognised the importance of pasture utilization and how much cheaper it is than supplementary feeding.

With this in mind, sheep when managed well, can play a very important role within a mixed enterprise with their ability to mitigate the potential downside risk of any single enterprise such as cropping.

Most meat sheep producers are looking for high fecundity rates which are highly desirable and suited to smaller flocks and high input systems, as in Ireland, where the average ewe flock would be at or fewer than one hundred ewes and a lot of ewes are housed during lambing. The Australian Merino producer doesn't want to lose sight of fecundity however with the more extensive lower input systems the major focus should be on twin survival, which is still at unacceptably low rates. This factor will have a far bigger impact financially than chasing sheep which are highly fecund but do not have the management or nutrition available to match the level of care needed by the ewe. The other factor to take into consideration is the value of the

Merino ewe's fleece which in some cases can be worth as much as a poorly finished twin or triplet lamb.

Recommendations

To achieve optimum profitability all sheep breeders need to:

- ***Achieve the target birthweights.*** This is the number one influencing factor for lamb survival.
The optimum birth weight for each size of litter (Keedy, 2015).
Single = 6kg
Twin = 5kg
Triplet = 4.5kg
- ***Set breeding values.*** To make maximum impact on any breeding system there needs to be some objective measurement introduced.
- ***Fit not fat.*** Ewes should not be less than CS3 for joining or lambing. However, ewes that are over CS 3.8 will have issues with being fat, such as high dystocia rates in single bearing ewes and lazy lambings in twin bearing ewes.
- ***Pregnancy scanning.*** This management tool can dictate the lifetime performance of the subsequent lambs. Pregnancy testing also gives a report card on how well the farmer has managed ewe nutrition.
- ***Pasture management.*** This is an area where Australian sheep farmers can learn from the New Zealand, Irish and British farmers, who rely on what they grow primarily for all their feed requirements, as supplement is not as readily and cheaply available as it is in most parts of Australia. There is also an opportunity to introduce a highly digestible protein source in late pregnancy for multiple bearing ewes as the pastures are high in energy but can be low in available protein. This can assist in increasing birth weight and growth of lambs it can also assist in reducing the worm larvae output by the ewe.

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Plain English Compendium Summary

Project Title:	Name of project
Nuffield Australia Project No.: Scholar: Organisation: Phone: Fax: Email:	Tim Gubbins Nuffield Australia, 586 Moama NSW 2731 0428 115 873 tim_gubbins@hotmail.com
Objectives	To investigate the best practice in sheep breeding systems from Australia and the world, to improve the lamb survival rate from the first 48 hours through to weaning, focusing on: <ul style="list-style-type: none"> • Nutrition • Pasture management • Fertility traits • Breed objectives • The role of discussion groups
Background	Australian lambing percentage has not risen beyond 80% and only marginally increased over the last 30 to 40 years. The Australian sheep producer can make anywhere from \$12 to \$49 profit per lamb, depending on the enterprise.
Research	Undertaken through travel in New Zealand, England, Wales, Scotland, Ireland and Uruguay. While in these countries I interviewed researchers, consultants and farmers.
Outcomes	Reducing lamb mortality is possible. Sheep producers around the world are also struggling with lamb losses and are very focussed on this issue. The common factor that has the biggest impact on improved lamb survival is through focused nutritional management. Correct pasture utilisation is critical in addressing nutrition, increasing lamb survival, weaning weights and profits.
Implications	Without a focused effort from sheep producers the Australian lambing percentage will remain where it is. By outlining a breeding objective, producers can then set about implementing a nutritional and genetic strategy for their flock. By understanding the breed and nutritional requirement many sheep producers in Australia could certainly reduce lamb wastage and increase pasture utilisation which will increase overall farm profitability.
Publications	