Optimising the reproductive potential of sheep production systems

A report for

by Carly Buttrose

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Executive Summary

Through travel to major sheep producing countries the United Kingdom (England, Wales, Scotland and Northern Ireland), New Zealand, Chile and Uruguay the following recommendations have been made which could assist the Australian sheep industry to improve the current reproductive average.

- Nutrition is the single most important factor to maximise reproductive performance and resulting lamb survival. This poses more of a challenge in Australia's environment than some other countries.
- Identification and preferential treatment for feed and shelter for ewes with twins and triplets as multiple births are at the highest risk of peri-natal mortality.
- The selection of maternal breed has a significant effect on the prolificacy and maternal ability of the ewe, however, there is more genetic variation within a breed than within breeds so it may be a matter of selecting superior mothers from the existing flock for future breeding.
- Strict selection and culling practices for reproductive and maternal traits will move the fertility and productivity of the flock forward. The use of an EBV for maternal ability could assist producers in selecting better suited mothers for breeding replacements.
- When selecting a maternal breed consider the adaptation of that breed for a particular region or environment, especially when breeding ewes out of season.

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Foreword

This study has been conducted through the Australian Nuffield programme in conjunction with sponsorship with Rabobank. I was inspired to apply for this scholarship after listening to a well respected industry personality speak at the national lamb conference LAMBEX of Australia's poor record for 'reproductive wastage' in the sheep industry and the fact that this was known and has not changed for nearly 30 years. This coupled with frustration within my own business that we too were contributing to this issue with below optimum lamb survival and conception rates inspired me to delve further. Further research indicated that other sheep producing countries such as the United Kingdom (UK) and New Zealand (NZ) were having considerably more success in reproductive efficiency than in Australia. I felt I needed to see these sheep industries first hand and determine why it seemed they were having considerably more success than Australia, the home of one of the largest sheep flocks in the world.

My Nuffield Scholarship has given me the opportunity to visit countries such as the UK, NZ, Chile and Uruguay in pursuit of finding management practices to assist in optimising the reproductive potential of the national ewe flock. During the period of my study, I came to realise that whilst we farm different breeds in different environments the overarching challenge faced by all producers is providing adequate nutrition to the pregnant ewe. Some countries environments make this easier than in others but it was reassuring to know we are all facing the same issue.

After observing agriculture over four continents in four months and learning of the high levels of subsidies and regulation in many agricultural economies, I returned to Australia with a sense of pride that we are one of the few agricultural economies in the world who have to operate as a genuinely profitable business. Whilst this can be a challenge at times, we have become some of the best farmers in the world because of it.

Acknowledgements

Firstly I would like to acknowledge Rabobank, who have generously sponsored the Nuffield Scholarship I undertook; it is fantastic that they see the benefit in investing in Australia's young farmers. I would also like to thank Nuffield Australia for allowing me to become part of what is a wonderful institution and platform for learning and personal growth.

A big thank you must go to all the wonderful people in the global agricultural community who so generously shared their experiences and knowledge with me during the period of my study.

To my husband Adam, who after just three months of marriage, saw me off on my Nuffield adventure! Your love and support of me through this journey has made it all the more enriching.

Last but not least, thanks to my family who had to pick up the slack while I was away; spending four months away from the business once seemed impossible but everyone coped so well I think I should make it an annual thing!

Abbreviations

BCS – Body Condition Score

CAFRE – College of Agriculture, Food and Rural Enterprise

CNS – Central Nervous System

EBV – Estimated Breeding Value

EID – Electronic Identification

MBS – Maternal Behaviour Score

NZ – New Zealand

RFID – Radio Frequency Identification

SNP – Single Nucleotide Polymorphisms

UK – United Kingdom

Objectives

To fully investigate the topic of improving reproductive efficiency within a sheep production enterprise, the following objectives were set to focus this study.

- To investigate the importance of prolificacy within the ewe flock and how it affects reproductive efficiency, as well as the factors effecting prolificacy and why similar sheep will be more prolific in some countries not others.

- To investigate the parameters determining lamb survival; in particular the survival of lambs in the first 24 hours after birth.

- To research the impact of ewe maternal behaviour on reproductive efficiency and how it can be used to improve lamb survival.

Chapter 1: Introduction

Reproductive efficiency in a prime lamb producing ewe flock is a key driver of profitability (Cottle, 2010), and lamb survival is known to be a key component of reproductive efficiency (Hinch & Brien, 2014). The loss of lambs in late pregnancy and up to weaning is a significant contributor to reproductive inefficiencies in the Australian sheep industry and probably most sheep flocks around the world (Hinch & Brien, 2014).

Average lamb marking percentages in Australia remain at 79% and have not fluctuated significantly in 30 years (Cottle, 2010). Producers often do not understand why this figure is so low. Reproductive wastage in the Australian sheep flock is high with some Merino flocks in Southern Australia recording as low as 42.4%. This issue was the focus of several reviews in the 1970's and 80's which provide the basis for much of our present knowledge (Alexander, 1984; Hinch & Brien, 2014). Lamb losses in multiple litters are usually two to 2.5 times higher than those for a single birth in the same flock, and as producers have driven to increase prolificacy and the rate of twin births, this has put greater pressure on lamb survival. Eighty percent of lamb losses occur in the first 48 hours of life usually due to dystocia, malnutrition, mismothering and exposure making this period and the weeks leading up to it critical to managing correctly if reproductive efficiency is to be improved (Hinch & Brien, 2014).

Other sheep producing countries, such as New Zealand, have been able to make marked improvements in their national lamb marking percentage. New Zealand farmers are currently averaging 126%, up from 100% 20 years ago. The United Kingdom consistently reports lamb marking percentages greater than 170% (Vipond, 2013). Observing these statistics, Australian producers could certainly learn from producers and academics in these countries.

Reproductive wastage is costing Australian lamb producers a significant percentage of their business profits, not to mention the animal welfare implications it creates. This study aims to address the factors that affect reproductive efficiency in ewes, and observe the practices of other lamb producing countries enabling them to manage for better lamb survival and subsequent profitability.

Chapter 2: Sheep production; a global overview

The countries visited as a part of this study where chosen to encompass some of the larger sheep producing countries in the world. Countries visited included the United Kingdom (England, Wales, Northern Ireland and Scotland), South America (Chile and Uruguay) and New Zealand.

United Kingdom

The United Kingdom sheep flock is diverse in its breeds, however, as nearly all breeds are primarily lamb focussed, there is little to no importance put on wool value. Common maternal breeds in the UK are the Texel, Mule, Bluefaced Leicester, NZ Romney, Cheviot and Scottish Blackface. Common terminal breeds are Black Suffolk, Texel, Dorset and Beltex (a double muscled Texel). There is also a trend to moving to more prolific breeds such as the Aberdale and Cambridge (carriers of the Inverdale gene) as well as the Welsh breed, the Lleyn. UK sheep flocks are quite small in comparison to Australia with an average of 200 ewes per flock, but with some producers running as many as 3,000.

UK grazing land is often categorised as lowland and Hill land. The lowland areas are more productive, tend to be smaller holdings and have a more intensive approach to stock management. Hill farms are generally made up of more native pastures, are not as productive and are managed more extensively. Lambing percentages for lowland farms are usually 180-200% and Hill farms are lower ranging from 135-160%. Lambs are usually born in late winter and early spring and finished on pasture and forage crops, as well as some concentrates. Lambs are grown in three to five months to a carcass weight of 18 kg.

UK lamb producers largely still lamb indoors, especially those who are lambing in late winter. There is certainly a push from industry leaders to move to a less intensive outdoor lambing system to make the industry more competitive and attractive to the next generation of farmers.

Chile and Uruguay

Sheep production systems in Chile and Uruguay are quite similar to those in Australia. Chile in particular has a similar climate to southern Australia (especially the 5th and 6th regions of the country) characterised by hot dry summers and cool wet winters. Chile has 3.8 million

sheep and the biggest flocks are found in the southern tip of the country called the Magalinnes. The Merino and Corriedale are the most common maternal breeds and Black and White Suffolks are a common terminal cross. Chilean producers source large amounts of their sheep genetics from Australia and NZ, importing semen, embryos and live rams and have a large emphasis on trying to improve the genetic potential of their national flock.
Ewe nutrition in pregnancy is a big issue in Chile and Uruguay, where it is not common practice to feed ewes over the summer months when feed is limiting and ewes are in late gestation. A major reason for this is sheep producers do not live on their properties and often run them in absentia, which is a logistical issue. There is also a lack of education and quality extension in much of the sheep industry in South America. Sheep flocks are typically small, except in the 12th region where there are Merino flocks up to 2,000 ewes. Scanning rates range from 135-140% and marking percentages are typically 90-110%. Average lamb carcass weights are 14 kg, and it can take seven to nine months to achieve this. Sophisticated finishing systems are not common in South America; as a result lamb is still a very seasonal product with any out of season lamb sold frozen.

New Zealand

New Zealand is certainly an impressive sheep producing country, with a largely temperate climate. In most sheep producing areas there can be green feed available for nine months of the year. New Zealand lamb producers are running high performance, prolific ewes capable of marking 160 to 180% lambs. Common NZ sheep breeds are the Romney, Perindale and Coopworth, as well as a plethora of composite type ewes made up of a mix of Romney/Texel/East Friesian/Finn type breeds which are marketed heavily in the industry. The average NZ lamb carcass weight is 18 kg, with lambs finished by three to five months of age on natural pastures and specialist fodder crops. Feedlotting is uncommon due to the high price of NZ feed grains.
NZ lamb producers have made significant production gains; in the past 20 years breeding ewe numbers have reduced by 50%. However, NZ carcass production has remained almost the same. Changes in ewe breed composition during the early 2000's toward composites has contributed to improved lambing performance. Improved lambing percentages during the early 2000's have meant greater focus on management and survival of multiple births (Geenty, 2013).
Despite improvements in production efficiencies NZ sheep farmers are being challenged by a fast-growing and profitable dairy industry driving up land prices and making sheep farming

an unprofitable enterprise on the low lying productive flats of the country. As a result sheep production is being pushed into the more marginal hill country where NZ sheep producers have to adapt to survive.

These overseas sheep production systems are in some ways similar to Australia's sheep production systems but in other aspects are a stark contrast. The Australian sheep flock is the second largest in the world, consisting of 74.7 million sheep, second only to China (MLA, 2014). The Australian sheep industry was traditionally founded on wool production and the Merino breed. During this era of wool production the Australian flock peaked at 174 million in the late 1990's mainly due to the Australian Wool Corporation reserve price scheme. This scheme ceased in 1991 and sheep numbers have fallen ever since due to lower wool returns compared to other industries (Cottle et al, 2010). The prime lamb industry has become a large part of the Australian sheep landscape, with the introduction of British breeds on both the maternal and paternal sides to increase meat production. The Merino still makes up the majority of the maternal ewes, however she has become more of a dual purpose animal (wool and meat) compared to the past. Lamb enterprises tend to be located in areas of higher rainfall and more pastoral low rainfall areas are usually used for wool production.

Chapter 3: More lambs equal more profit

Lambing percentages at scanning, marking, or more importantly at weaning, are often a principle key performance indicator in a lamb producing system. The figure is calculated by dividing the number of lambs scanned/born/weaned by the number of ewes mated. Quite simply the more lambs weaned per ewe the more kilograms of lamb are available for sale and generation of income. This is a very common production strategy for many lamb producers worldwide and is in some ways correct, or is it too simplistic?

Dr Steven Johnson, a Sheep and Beef Geneticist for CAFRE in Northern Ireland, is a big believer in simplifying the benchmarking system in sheep production systems, and explained the importance of the ewe efficiency score.

Ewe efficiency is measured by comparing the weight of ewes mated to the weight of lambs turned off at weaning (116 days). It is the capacity of any particular ewe to rear the maximum kilograms of lamb in comparison to her mating body weight which is a key profit driver, not necessarily the number of lambs she weans. This measurement is quite simple to calculate in a commercial flock – only 20% of a mob needs to be weighed at mating to get the ewe's initial figure and 20% of the lambs from that mob need to be weighed at weaning (116 days of age). An ideal target efficiency score is 0.85, however Dr. Johnston explains that most sheep flocks in Ireland and the UK range between 0.5 to 0.8. So to put this theory in simple terms, the heavier a ewe is the more kilos of lamb she must turn off to maintain her efficiency. Likewise, smaller ewes need to turn off fewer kilograms of lambs to maintain the same efficiency score (Dr S. Johnston, Pers. Comm., August 2013).

In Australia, a common prime lamb ewe composition would be a F1 cross between a merino and Border Leicester or a pure bred merino. A F1 cross ewe (70-90 kg) is significantly heavier than even a highly productive Merino ewe (50-60 kg) so in order for a lamb producer running a F1 ewe flock to maintain efficiency over a lighter breed of ewe, that producer must either wean a larger lamb by weaning or wean more lambs from that ewe to weaning. This is where number of lambs and reproductive performance become very important.

3.1 Getting more lambs

3.1.1 Prolificacy

When considering a dam for a lamb-producing flock her ‘fertility’ or ‘prolificacy’ is often a key driver to selection. Prolificacy is a ewe’s ability to conceive a lamb, and some ewes will be highly prolific (conceive multiples) and others low. An individual animals fertility/prolificacy is usually first measured in a commercial operation at scanning (an ultrasound on a ewe 40 days after joining). As a result scanning rates or percentages are also used as performance indicator of a prime lamb flock – it is a producer’s starting point in terms of production and sets the lamb yield potential.

3.1.2 Breed

Different breeds have different levels of inherent fertility – some well known prolific breeds include the East Friesian, Finn, Border Leicester, Lleyn, Cambridge and Romanov (Cottle, 2010; Vipond, 2013). Their prolificacy can be very high and as a result these breeds are often used in F1 or composite crosses to harness this trait. This can be seen in NZ in particular where maternal composite type ewes are very popular with lamb producers. The addition of a prolific breed in the composite ewe gives lamb producers a greater genetic potential for fertility and therefore profitability. Almost no consideration is given to the wool quality of the maternal cross. Both NZ and UK producers are dedicated meat producers and feel ‘dual purpose’ breeds with improved wool qualities such as the Merino are detrimental to focussed lamb production.

There are also the Booroola and Inverdale breeds which have incorporated a gene for high prolificacy in their breed giving a ewe who will, in a F1 situation, give in excess of 200% lambs at scanning (Catherine Nakielny, Pers. Comm., July 2013). Other breeds such as the Merino have quite low prolificacy, purely because historically they have not been selected on this trait but selected for wool attributes.

3.1.3 Inverdale & Booroola genes

Prolific breeds, especially the Booroola and Inverdale breeds, can pose some problems (Vipond, 2013). Whilst producers want a ewe with the potential to conceive multiple lambs, it would be ideal if the litter size could be limited to twins, avoiding triplets and quadruplets due to the lower growth and survival rates of the larger litter sizes (Mathias-Davis et al, 2013).

However, as scanning percentages increase past 160% the number of singles decreases and number of triplets increases. When lifting conception rates above 160% specific management practices need to be implemented to manage the large percentages of triplets (Dr. Julie Everett-Hincks, Pers. Comm., August 2013).

During this study, observations of the success of the Inverdale gene were made, especially in the UK. Innovis, a Welsh-based sheep stud specialising in composite dams and sires incorporating the Inverdale gene, is well known in the UK for their promotion of the fertile gene. Most sheep producers interviewed on this topic conceded that the high prolificacy of the breed was very difficult to manage and had subsequently moved away from the breed. Those producers who were having success with the breed have put management procedures in place to manage the high lamb numbers and subsequent demands on nutrition. 'Negative flushing' is one strategy, where Inverdale ewes are put on a limited diet in the lead up to and during joining to prevent high numbers of eggs being released during ovulation (the ewe "believes" that limited feed conditions are imminent and will decrease litter size to aid in survival) (Catherine Nakielny, Pers. Comm., July 2013*).*

In conjunction with the management of ovulation rates, most producers successfully using the Inverdale gene are also lambing in an intensive indoor situation. This allows the 'cross fostering' of the third lamb in a triplet litter to a ewe with a single lamb. This practice allows most lambs to be reared as a twin who have a higher chance of survival and greater growth rates. Lambing indoors and cross fostering takes a significant amount of labour and capital expenditure and farmers using this system admit that a 200% lambing rate is required to maintain profitability (Catherine Nakielny, Pers. Comm., July 2013).

When interviewing Dr Johnston, a UK sheep geneticist, he revealed a very sound theory, '*it's evolution not revolution*' when it comes to sheep breeding and he feels that "*the Booroola and Inverdale genes put too much pressure on a system and whilst it may be successful for a couple of years, it is a high risk approach and has a high chance of imploding*" (Dr S. Johnston, Pers. Comm., August 2013).

3.2 Genetic selection versus environment & nutrition

Whilst some breeds show inherent traits for increased fecundity, there is still a large variation within the breeds for individual ewe performance, and it is well documented that the heritability for fertility and prolificacy is quite low (0.05 -0.1 respectively) (Cottle, 2010). It

could take up to 12-15 years to make any genetic progress for these traits if a producer began selecting individuals which have multiple offspring from which to breed. British breeds tend to have better fertility than a Merino but even so they do not perform as well in Australia as they do in the UK. This became very clear during this study where UK sheep producers were scanning 180-200% regularly in their composite British breed ewes, with no particular attention to specific management practices to ensure this. A similar composite sheep in Australia would range between 115-160% which is a big variation, not to mention the variation within the Australian British breed flock (Cottle, 2010).

A large part of this study was to determine why this occurs. Why do sheep in Australia have seemingly lower fertility in comparison to their UK ancestors? The answer to this question lies in two factors; environment and nutrition.

3.2.1 Breeding seasons

The biggest difference between the UK and Australian production system is the reversal of the seasons in the Northern and Southern hemispheres. This has a large bearing on ewe reproduction as the sheep is seasonally polyoestrus and their breeding cycle usually precedes the spring by five months (with the exception of the Merino which is far less sensitive to seasonal breeding). In the Southern Hemisphere the breeding season is from February to June with a peak in March – April (autumn equinox) and the two months following. In spite of this most sheep in Southern and Western Australia are bred in December and January, during the summer months, for a winter lambing to ensure that there is sufficient time after birth for the lamb to gain weight for slaughter before feed quality declines at the beginning of summer (Cottle, 2010). Australian sheep producers have a different climate to work with (Mediterranean vs temperate in UK and NZ) which pushes ewe mating out of the 'ideal' zone.

This situation can also be observed in areas of South America. Chile, in particular the mid and southern areas of the country, also has a Mediterranean environment. Chilean lamb producers will join ewes from December to January aiming to lamb their ewes from May to July and tend to scan 135% to 140%, but only mark 90 -110%. This reproductive wastage is commonly due to poor nutrition during pregnancy as supplementary feeding ewes over the summer months when feed availability is low is not a common practice (Dr Juan Garcia, Pers. Comm., August 2013)

In comparison, the UK ewe is usually joined from November to January in the northern Hemisphere autumn and winter for a spring lambing. This coincides much better with the sheep's natural breeding cycle, not to mention matching ewe feed demand to feed on offer.

Similarly in New Zealand, as NZ has a more temperate climate like the UK, the joining period is also later than Australia, occurring during the autumn months for a Spring/early summer lambing – better matching the ewe's breeding cycle.

The nature of Australia's early joining predisposes Australian lamb producers to using longer joining periods to ensure all ewes are mated. This may reduce the efficacy and prolificacy of ovulation resulting in lower fertility. This must particularly be kept in mind when considering removing the Merino component from the maternal line, as having 50% Merino in the cross removes some of the seasonal breeding requirements (Cottle, 2010).

3.2.2 Nutrition during joining

Body condition score (BCS) is a well documented way to measure a sheep's condition and is a good way to measure the fat reserves of a sheep at any particular moment in time. BCS is graded from 1-5 with 1 being emaciated and 5 being very fat. It is recognised in the UK, NZ, Australia, Uruguay and Chile that a pregnant ewe should maintain a BCS of 3 through the pregnancy for optimal lamb and ewe survival (Lifetime Wool 2013; Dr Georgett Banchero, Pers. Comm., August 2013; Dr Juan Garcia, Pers.Comm., August 2013).

BCS is also very important during the joining period and can determine if a ewe conceives as well as the litter size. This is particularly well understood in NZ and NZ lamb producers will pay particular attention to this during the joining period. Ewes must be of a BCS of at least 3 at joining but more importantly they must not be on a declining plane of nutrition. A ewe can be of BCS 4 but if she is losing weight during joining, the chance of her conceiving a twin is reduced (Dr Peter Anderson, Pers. Comm., August 2013). This was well pointed out by Dr Paul Kenyon (Pers. Comm., August 2013) of Massey University in NZ who explained the trend of having special autumn/winter pastures to join ewes on to ensure ewes were maintaining or increasing BCS during this period.

The UK and NZ ewe is joined in autumn and early winter (Dr John Vipond, Pers. Comm., July 2013). Whilst this is usually a period of reduced feed growth going into the colder

months, there is usually some availability of green feed and a dry ewe will be able to maintain her BCS at the very least. In Australia, ewes are joined during the summer months when there is no green feed and the dry feed is beginning to lose quality (Cottle, 2010). In this situation it can be difficult to have ewes on an upward plane of nutrition during joining. This is often addressed by Australian lamb producers by 'flushing' the ewes. That is feeding ewes a grain supplement to maintain or even gain BCS.

In conclusion to this discussion of prolificacy and fertility in the ewe, there are some significant differences between the production systems in the UK and NZ which have higher recorded scanning rates compared to Australia. The environmental and seasonal differences as well as the nutritional contrasts between the countries are largely fixed and will always make direct comparisons between the systems difficult. Whilst there are certainly things Australian producers can adjust to suit the breeding season of British breed sheep and address the nutritional challenges our sheep face, we are largely restricted by our Mediterranean environment and rainfall.

Chapter 4 – Lamb survival

The first step to optimising ewe reproductive performance is certainly by improving the prolificacy and fertility of the ewe. The second step, and often the most complex to manage, is lamb survival. Having a fertile ewe is only going to increase profitability if she can rear those lambs successfully. Different countries visited in this study had different survival rates, with the UK having the highest and Chile and Uruguay the lowest; the reasons for this will be discussed further in this report.

Perinatal lamb mortality represents a serious biological and economic problem in the sheep industry worldwide. It is defined as the death of lambs shortly before or during birth or during the first 28 days of life. In Uruguay, Australia, New Zealand and other sheep producing countries, perinatal lamb deaths average 10-20% with 80 to 90% of these occurring in the 72 hours after birth (Dutra et al, 2007). Mortality rates increase with increasing litter size as birth weight often decreases as litter size increases. This problem is particularly significant in Merinos, where losses in twins often more than double those in singles, while losses in crossbred ewes are usually lower than those from Merinos (Cottle, 2010).

The ability for a lamb to survive to weaning is determined by genetics, behaviour, physiology and the environment, including on farm management practices (Everett-Hincks & Dodds, 2008). Throughout this study and the numerous interviews conducted, the large percentage of lamb mortality was put down to dystocia and mismothering with predation and misadventure secondary issues.

4.1 Nutrition

4.1.1 Birth Weight

Ewe nutrition during pregnancy and early lactation is of paramount importance to lamb survival (Everett-Hincks & Dodds, 2008; Banchero et al, 2004) and has a direct correlation with the birth weight of her progeny. Figures 1 and 2, sourced from the Australian Lifetime Wool project, show that increased ewe BCS at lambing has a direct effect on the survival of her lamb, especially in twin bearing ewes. The Lifetime Wool project also showed that a lamb birth weight of 5 kg is optimal for survival (Lifetime Wool Project, 2010). Low birth weight

lambs are born with fewer tissue reserves, are less vigorous after birth and take longer to stand, reach the udder and suck than heavier lambs, so optimal birth weight improves lamb vigour (Mathias-Davis et al, 2013).

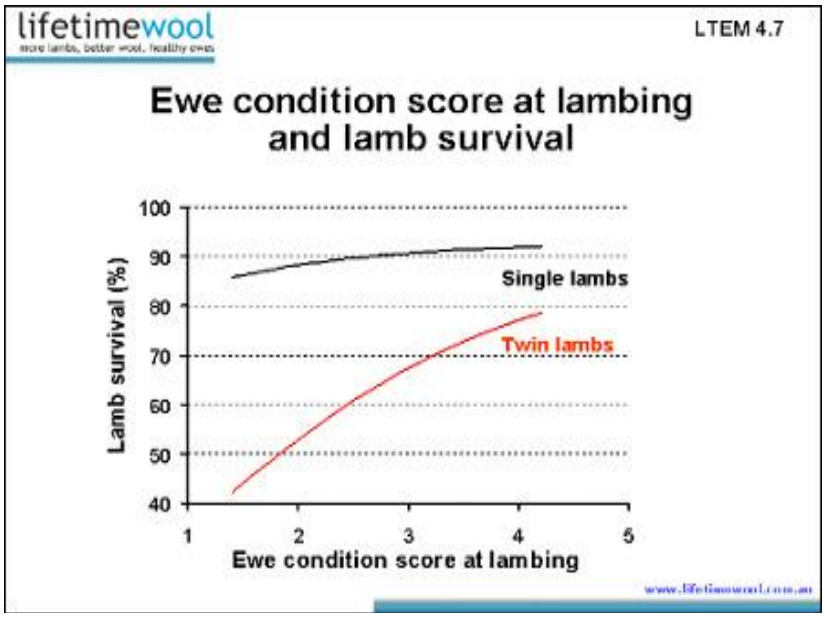
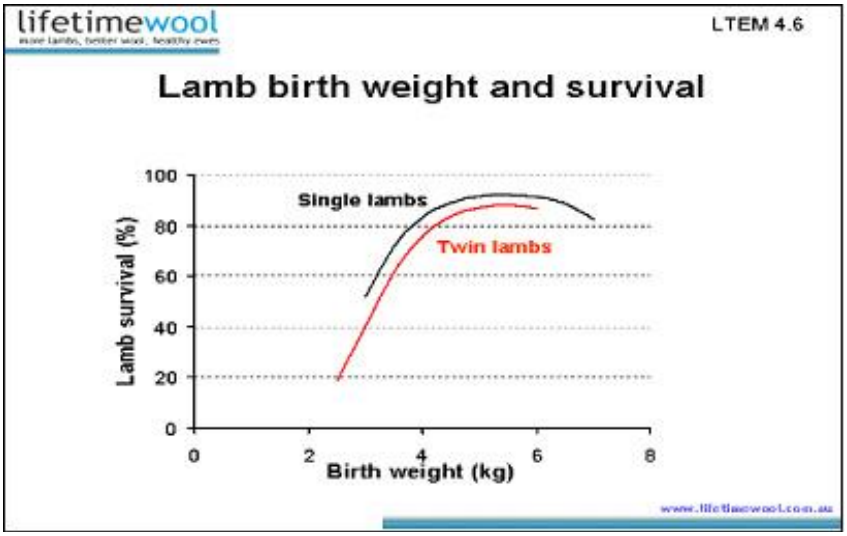


Figure 1: Ewe Condition Score at lambing and lamb survival (Lifetime Wool Project, 2010)



In an interview with Dr Banchero (Pers. Comm., August 2013) she explained that normally well-fed ewes will accumulate a large volume of colostrum in the days before birth and secrete milk copiously soon after lambing. Adequate supply of colostrum in the first few hours after birth has a major influence in survival as it is the most important source of energy the lamb receives. The presence of colostrum in the lamb's stomach has also been shown to help the lamb recognise its mother. Twin-born lambs are especially at risk because multiple rearing ewes produce less colostrum than single bearing ewes (Banchero et al, 2004).

When available nutrients fail to meet the mother's energy requirements she will mobilise fat reserves in the last month of gestation. Dr Banchero conducted a study which looked at nutrition on the effect of colostrum production in Merino ewes, She found that only feeding 70% of maintenance energy (ME) requirements was insufficient for adequate lactation (Banchero et al, 2006). These ewes lost condition in the last month of gestation, which was reflected in high β-hydroxybutyrate levels in the plasma (this is an indicator of mobilisation of fat reserves in sheep). Some sheep in the underfed treatment had levels indicating pregnancy toxaemia, although they did not show symptoms (Banchero et al, 2006). The well fed ewes (110% ME requirements) were able to maintain or slightly increase their BCS in the same period. The experiment suggested that 60% of the underfed ewes did not have enough colostrum to meet the requirements of their lambs. Minimum colostrum requirements for a lamb are 210 ml/kg body weight in the first 18 hours. The well-fed treatment produced 270 ml/kg in this time and the underfed ewes produced an average of 190 ml/kg in the first 18 hours. This is 10% less than requirement and would be even more deficient under cold weather conditions when demand for colostrum is higher (Banchero et al, 2006).

Energy in the form of glucose is important in late gestation, and grazing ewes often do not have enough glucose as a proportion of their total ME intake (Banchero et al, 2004). Dr Banchero conducted a trial where cracked maize was supplemented at 0.75 kg/head/day to both single and twin bearing ewes in the last week of pregnancy. Ewe colostrum production doubled in those ewes which were supplemented, especially in those ewes which were twin bearers. The colostrum in the supplemented ewes was also less viscous making it easier for lamb intake (Banchero et al, 2004). Therefore, the supplementation of ewes in the last week of pregnancy with a high energy feed source increases the ewes capacity for colostrum production, especially those bearing twins.

4.2 Pre-lambing shearing

Dr Georgett Banchero has described prepartum (pre-lambing) shearing as a possible tool to increase the weight of lambs at birth and weaning. Dr Ignacio Abella from the SUL Institute in Uruguay also described prepartum shearing as a management tool he recommends to growers to aid lamb survival. Dr Abella believes that shearing the ewes the month before lambing encourages ewes to seek shelter and improves access to the udder and anecdotally has shown to increase lamb survival by 10% (Dr Ignacio Abella, Pers. Comm., 2013).

The work of Dr Banchero and prepartum shearing refers to shearing the ewe in the first third of gestation (day 53) and has shown to increase milk production of Polwarth ewes as well as the weight of lambs at birth and weaning (Sphor, et al, 2011). The trial showed that milk production of ewes shorn at 53 days after conception was 22.2% higher when compared to the unshorn ewes in the trial, with no change in the milk composition. At lambing the lambs born to shorn ewes were 1.41kg, and at weaning 4.5kg heavier than those lambs born to unshorn ewes. It was concluded that the heavier weaning weight of the lambs from shorn ewes was due to both a higher birth weight and increased growth rate up to weaning in part because of increased milk production (Sphor et al, 2011).

In a separate study by Dr Banchero it was discovered that prepartum shearing also increased lamb vigour of single and twin born lambs shorn at 70 and 120 days of gestation. The shearing treatment prolonged gestation of the lamb by three days in twins and two days in singles. The improved vigour is thought to be due to the extra gestation length in the dam (Banchero et al, 2010). Lamb behaviour within the first hour was also influenced by shearing with 97% and 92% of twin lambs from the 70 and 120 day shearing treatments sucking within the first hour respectively compared to 68% in the unshorn control. Single lambs also had a significantly improved suckling rate in the shorn treatments but not to the extent of the twin lambs (Banchero et al, 2010). This indicates that shearing ewe's prepartum, at either 70 or 100 days of gestation, could be a good way to increase lamb survival, especially in twin lambs as their lower birth weights put them at risk.

4.3 Maternal Ability

Ability of a ewe to birth and rear a lamb is referred to as maternal ability and there is a large variation for this trait both between and within breeds (Cottle, 2010). Research by Dr Julie Everett-Hinks with AgResearch in Invermay, NZ, has highlighted the importance of maternal behaviour and ability on lamb survival. Maternal behaviour is often measured using the 'flight test' which is the distance a ewe will stray from her lamb when a shepherd is tagging her lamb after birth and is a good indicator of the 'ewe–lamb attachment'. This Maternal Behaviour Score (MBS) is rankled from 1 to 5 (Figure 3) and is directly correlated to lamb survival as well as lamb growth rate; the higher the MBS the heavier the lamb at weaning. The difference between a score four and a score three (retreating five metres compared to ten metres) can

equate to and extra 10kg of lamb weaned (Dr Julie Everett-Hincks, Pers. Comm., August 2013).

Figure 3: Description of maternal behaviour scores when assessed at tagging

Description of MBS	MBS
Ewe flees at the approach of the shepherd, shows no interest in the lambs, and does not return	1
Ewe retreats further than 10 m but comes back to her lambs as the shepherd leaves them	2
Ewe retreats to such a distance that tag identification is difficult (5 to 10 m)	3
Ewe retreats but stays within 5 m	4
Ewe stays close to the shepherd during handling of her lambs	5

Source: O'Connor et al, 1985

Ewe maternal behaviour score has a significant effect on lamb death risk, due to starvation, exposure and dystocia, where ewes with lower scores have higher lamb mortality rates (Everett-Hincks et al, 2008). Significant improvement in twin lamb bonding with the ewe occurs when the mother remains on the birth site for a minimum of six hours; this is also more likely to occur when both feed on offer and shelter is adequate and human disturbance is kept to a minimum (Everett-Hincks et al, 2008).

Ewe maternal behaviour is also related to nutrition. A ewe in poor condition, who has had to mobilise body fat to offset inadequate nutrition, will be a less attentive mother. This condition is often sub-clinical and not easily diagnosed in the paddock – she will be dopey and disinterested in her lamb (Dr Julie Everett-Hincks, Pers. Comm., August 2013).

Maternal behaviour is a heritable trait, with a 0.15 heritability and repeatability of 0.18-0.21, which is certainly not high but indicates selection using a MBS will assist in improving the mothering ability of a flock (Dr Julie Everett-Hincks, Pers. Comm., August 2013). There are some seedstock breeders which are scoring the MBS and using the information to create an Estimated Breeding Value (EBV) for maternal ability. One of those producers is Andrew Welsh from Twin Farms in Gore, NZ. The Welsh's breed a composite maternal line called the TEFRom (Texel, East Friesian and Romney) which has been selected for ewe fertility and ability to maintain body condition (Andrew Welsh, Pers. Comm., August 2013). The Welsh's

have worked extensively with Dr Everett-Hincks in researching lamb survival and see the EBV for maternal ability as a positive step to improving lamb survival for their clients.

Photo 1: Lambing TEFRom ewes seeking shelter during inclement weather, Twin Farms, Gore, NZ. Source: C Buttrose August, 2013

4.4 Dystocia

Difficult lambing is referred to as dystocia; this causes the majority of lamb deaths at or early after birth. It is used as a general term for birth injury and can be caused by many things. In an interview with Dr Georgett Banchero (Pers. Comm., August 2013), a well known sheep scientist who has specialised in lamb survival at INIA in Uruguay, she revealed that there is another underlying cause of lamb death which is commonly diagnosed as dystocia, Central Nervous System Lesions caused during birth. Dr Banchero explained that despite marked improvement in ewe and lamb nutrition and health control in sheep flocks around the world, the high perinatal mortality rate for lambs does not appear to have changed significantly during the past decades and remains an intractable problem for sheep producers. She also mentioned that whilst conception rates may be improving, this is not resulting in increased weaning percentages because of the high mortality rate of twin lambs.

4.4.1 Role of Central Nervous System lesions

In a trial conducted by Dr Banchero, the role of lesions in the central nervous system (CNS) of lambs were investigated and found to be strongly associated with perinatal lamb death (Dutra et al, 2007). Essentially during the birthing process, significant physical damage is

done to the CNS (Photos 2 and 3), causing haemorrhages and oedemas in the spinal column and in the brain. The findings of the study suggest that these CNS lesions may be a major component of perinatal lamb mortality and thepresence of lesions in lambs dying after six days after birth support this conclusion. It also means that lambs which are diagnosed as dying from mismothering or exposure in the six days after birth may also be victim to this form of dystocia and are being misdiagnosed. Dr Banchero also mentioned that she has observed that this condition, especially the damage to the cervical column of the lamb, is more pronounced in the Merino breed (Dr Georgett Banchero, pers. comm., August 2013).

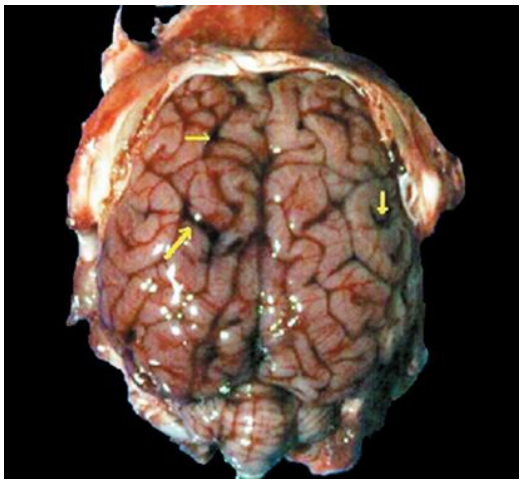


Photo 2. Brain of lamb that died 24 hr post partum. Multiple meningeal haemorrhages are present (arrows). The cerebral hemispheres are congested and oedematous with flattening of gyri and shallow sulci. (Dutra et al, 2007)

Photo 3. Cervical column of lamb that died at birth. At the level of the atlanto-axial joint (arrow) there is haemorrhage and oedema in the vertebral canal (symbol) and haemorrhages of the cord. Note the small mass of the supporting neck muscles and cartilaginous nature of the skeletal elements. (Dutra Et al, 2007)

4.4.2 Role of Vitamin E & Selenium

Dr Peter Anderson, a Vet specialising in livestock production systems in the South Island of NZ, has a very interesting theory on the role of trace elements, in particular Vitamin E and

selenium, on the role of lamb survival. Dr Anderson runs a programme called Optilamb with his farming clients and to date he has recorded the reproductive performance of 80 sheep producers for nearly 20 years, when many of his clients first started pregnancy scanning. This large data base has been used by Dr Anderson to make a strong case for the role Vitamin E and other antioxidants play in lamb survival. One of the prime roles of Vitamin E and selenium is as a potent antioxidant inside the cell wall to prevent damage from cellular metabolism. Severe deficiency will present as white muscle disease, but mild/subclinical deficiency will cause leaky membranes (Photo 4) (Dr Peter Anderson, Pers. Comm, August 2013).

Selenium and vitamin E are essential antioxidants in sheep diets and work together to prevent and repair cell damage in the body. Deficiencies of either or both selenium and vitamin E can cause weaner illthrift, reduced wool production, reduced ewe fertility, reduced immune response and white muscle disease. Whilst Vitamin E and selenium have a similar function in the body, they have different target sites so one cannot be substituted for another. Vitamin E is poorly transported by the placenta and lambs rely on Vitamin E in colostrum for their early supply, possibly increasing the mothers need for selenium at this time (Suttle, 2010). Areas of selenium deficiency are wide spread in Australia, particularly in regions of high rainfall and intensive livestock production (Trace Elements in South Australia). Factors contributing to low selenium status in the soil are waterlogging, low pH, high iron concentration and application of super phosphate (Trace Elements in South Australia). Vitamin E deficiency occurs when sheep are on dry feed for long periods and is more common in lambs and weaners.

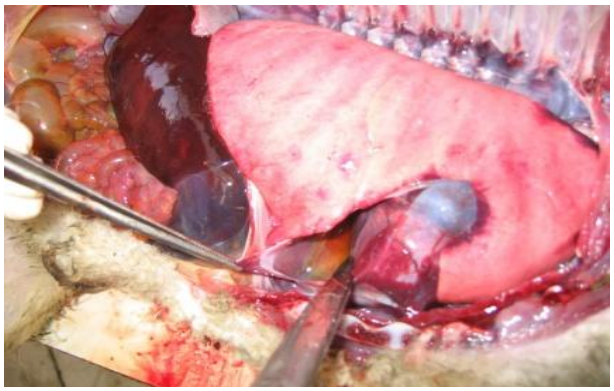


Photo 4: This little bit of extra pericardial fluid is probably very significant. This lamb was an early perinatal death as seen by fat mobilisation. It had a low liver Vitamin E – excess fluid in pericardial sac and pleural cavity (Dr Peter Anderson, pers.comm, August 2013)

Vitamin E is present in green feed and for ewes with a diet of hay, grain or dry feed the requirement for Vitamin E will be much higher than what can be supplied from the feed on

offer. The stress associated with inclement weather, shearing or crutching on top of pregnancy, birth and lactation can also increase the Vitamin E requirements (Dr Peter Anderson, Pers.Comm, August 2013). Dr Anderson has discovered Vitamin E deficiency in large numbers of NZ lambs through identifying leaky membranes resulting in excessive pleural and pericardial fluid. Without post mortem investigation for evidence of these leaky membranes, many lambs with this condition will be considered to die of dystocia.

Dr Anderson has developed a specific product to address this issue called VetLSD (livestock survival drench) which is comprised of Vitamins A, D, E, C, selenium, iodine and chromium. He has trialled this product with his Optilamb group with increases in scanning and docking percentages as well as decreases in lamb losses in ewes treated with VetLSD compared to untreated.

Vitamin E in late pregnancy has shown to be beneficial to UK sheep flocks as well where improved lamb vigour has been reported with supplementation (Vipond, 2013). Vitamin E is of particular importance in UK flocks, as a large number of producers lamb the ewes indoors and the ewes can spend up to eight weeks prior to lambing indoors on a grain/hay/silage ration.

4.5 Weather & Shelter

Lamb survival is predominantly controlled by the environment and weather conditions have a highly significant effect on lamb survival (Vipond, 2013). As most sheep flocks around the world are grazed in extensive pasture systems, weather is a critical factor in lamb survival. Inclement weather during lambing is often cited as the reason for poor lamb survival and in most cases is a contributing factor. In separate studies, by both Dr Everett-Hincks and Dr Banchero, it has been found that heat loss from a ewe in the lead up to lambing had a greater impact on lamb survival than heat loss recorded on the day of birth or after birth (Everett-Hincks, 2008, Banchero, 2004).

It is likely that weather conditions in late pregnancy are influencing the energy balance of the ewe when her energy requirements are the greatest, particularly for ewes with twins and triplets. The energy deficit is usually met in the ewes by increased feed intake, except in late pregnancy when the rumen capacity is shrunk by the foetus' she is carrying or there is inadequate feed on offer (Dr. Georgett Banchero, Pers Comm., August 2013). If the deficit is not met the ewe will mobilise fat reserves to compensate, but in times of severe heat loss this

may not be enough for ewes carrying multiple litters and may significantly affect lamb vigour and subsequent survival (Everett-Hincks, 2008).

New Zealand Beef and Lamb trials have shown that providing shelter has a positive effect on lamb survival. Trials have shown an increase of survival in singles from 83% to 91% and from 49% to 64% for multiples when shelter was provided to winter lambing Merino ewes (Geenty, 2013). It can be difficult in some paddocks for ewes to seek shelter during inclement weather as a ewe will choose to isolate herself from the mob to give birth. Often the non-lambing ewes will be in the shelter or on the more sheltered flats, forcing ewes onto more exposed ridges and hills. As not all paddocks have adequate shelter, it is best to prioritise those paddocks with shelter to ewes with multiples, as they are the most at risk and have a lower rate of survival. The allocation of adequate shelter is particularly an issue where ewes are lambing during inclement weather in winter and for multiple bearing ewes (as twin lambs are more at risk of mortality) (Lifetime Wool, 2013).

4.6 UK Indoor lambing vs outdoor

Housed lambing systems are an extreme example of providing shelter and are not commonplace in Australia like they are in the Northern Hemisphere.
Lamb producers in the UK have traditionally lambed indoors to improve lamb survival, and certainly have a reputation for actively assisting lambing and having labour intensive management practices. UK farmers lamb indoors for a number of reasons, especially the weather. If a farmer wants to lamb earlier to take advantage of early season lamb price then lambing occurs during the end of winter, which in some areas of the UK is quite hostile. One way to negate this is to lamb indoors. Lambing indoors is also used as a pasture management tool and provides a period of time that stock are kept off the pastures at the end of winter/beginning of spring, to allow pastures to re-establish and maximise growth rates.

Mr Robert Dalrymple of Cairnryan in Scotland is one farmer who has chosen this system. The Dalrymple property is scanning Mule breed sheep at 205% and marking 185% but admits this high lambing percentage is necessary for economic return as lambing indoors is costly. Robert lambs over a three week period and the lambing shed is manned 24 hours a day. The intensive and confined nature of the shed means that disease is a big risk and to avoid lamb mortality broad-spectrum antibiotics are administered to lambs at birth as is a navel dressing of antiseptic. The majority of ewes have an assisted lambing as Robert says *"if you are*

standing there and see her begin lambing, you just pull it out to be safe" (R. Dalrymple, Pers. Comm., July 2013). Triplets in this system are often cross-fostered. Ewes will spend three weeks indoors prior to lambing and will typically be put out on pasture or supplementary fed silage in the paddock three days after lambing.

Photo 5: One of the indoor lambing sheds on Mr Robert Dalrymple's property, note the partitions in the centre which are assembled to separate ewes at lambing. Photo: C Buttrose, July 2013

In a discussion with 2005 Nuffield Scholar Mr Neil Perkins, the effect of weather in his Welsh lambing operation was of high significance. His farm is coastal and quite exposed to extreme wind chill and low temperatures. After completing his Nuffield study in 2005 he returned from NZ committed to lambing his 2,000 ewes outdoors. In that season he scanned 185% in his Lleyn ewe flock but only marked 120%. Mr Perkins saw this loss as too costly (losing up to 150 lambs per day if there was a storm or rain) and not good from an animal welfare perspective and resigned to lambing indoors. In his indoor system he is only losing 10% of lambs from scanning to marking. His sheep remain indoors for eight weeks prior to lambing and are fed silage and concentrates (N. Perkins, Pers. Comm., July 2013).

Despite the weather challenges many UK farmers are moving toward outdoor lambing. A need for a simpler system, a system which is attractive to the younger generation and a lower cost system is being sought. Ram breeding in the UK is quite behind that of Australia and NZ, where only 8% of flocks are performance tested and there is still a heavy emphasis on breed characteristics or what a ram 'looks like' in selection, not necessarily production traits (Vipond, 2013). This coupled with the historic indoor lambing and assistance at lambing means there is not an ideal genetic pool available for an easy care, outdoor lambing flock.

Lamb producers trying to simplify their system and lamb outdoors have started their own ram breeding programmes on farm for various easy care breeds. The most popular breed being the

‘Easycare’, a wool-shedding maternal line based on the shedding ability of the Wiltshire Horn. Campbell Tweed, a 1993 Nuffield Scholar, farming in Larne, Northern Ireland, has transitioned to Easycares after losing faith that the UK wool market would ever improve. Mr Tweed is currently achieving 146% scanning and weaning 136% with the entire system run outdoors.

Photo 6: Easycare Ewes at the property of Dr Steven Johnston, Larne, Northern Ireland
Source: C Buttrose, July 2013

4.7 Selection & Genetic tools

Lamb survival and ewe rearing ability involve a complex physiological and behavioural interaction between lamb and ewe. Therefore, a simple single trait genetic approach to improve lamb survival remains elusive (Cottle et al, 2010). However, there are a range of selection tools which can be used to assist in the selection process.

4.7.1 Culling

Many reproductive traits can be easily selected for within a commercial flock by strict culling, especially within replacement ewe flocks. Ewes which require assistance at birth or fail to successfully rear a lamb to weaning should be culled. The effectiveness of culling on improving the reproductive efficiency of a flock is keenly observed in the UK. As UK flocks are smaller and often lambed under supervision poor mothers can be easily identified and culled from the flock, or at the very least made sure that none of her daughters are kept as replacements.

4.7.2 DNA Technology

With the development and refinement of single nucleotide polymorphisms (SNP) technology, difficult-to-measure traits become easier to measure. In a discussion with Dr Tim Byrne of Abacus Bio in NZ, he explained the potential of the technology. Dr Byrne currently sees commercial DNA technology being of the most benefit to determine parentage within stud flocks, which helps remove pedigree errors due to mismothering, which can have a big impact on the accuracy of EBVs (currently there are 10% levels of incorrect parentage when relying on tagging at birth) (T. Byrne, Pers. Comm., August 2013)

Maternal ability is the focus of the NZ SNP objective, whereas Australia has more focus on growth rates and eating quality traits. Dr Byrne is not confident of developing a SNP for lamb survival as it is a very complicated trait which is controlled by many genes and the environment. There is, however, a SNP being developed for body condition score which is 30% heritable which could go a long way to addressing some of the reasons for poor lamb survival.

Sharl Leibergreen, technical services manager for Zoetis NZ, the company which has commercialised the DNA parentage test and SNP technology in NZ, sees DNA technology as the future in sheep breeding. SNP technology will not replace the EBVs which are currently used but will be used alongside EBVs to create a 'Genetic Breeding Value' which will have more accuracy than an EBV alone (S. Leibergreen, Pers. Comm., August 2013).

4.7.3 EID technology in Selection

Currently the most common way to select for a ewe with improved maternal ability is to conduct the Flight Test soon after birth. This is a time consuming process and whilst is suitable in a stud breeding scenario, it is too laborious in a commercial system. By identifying the highly productive ewes for retention in the breeding flock and culling or joining the lowest performing 25% to terminal sires, a producer can significantly improve the genetic value and long term earning potential of the next generation of sheep (Sheep CRC, 2014).

Pedigree Matchmaker, developed by Steve Semple and the Australian Sheep CRC, is a system that records association of ewes with their lambs by recording their radio frequency identification (RFID) tag as they move onto an area such as a water point, lick or other attractant, and relies on the sheep behaviour that a lamb closely follows its mother. It is

possible to match over 95% of lambs to their mother in less than four weeks. This becomes valuable to both seedstock and commercial producers as they can use this data to identify their more efficient breeding ewes to ensure they are maintained in the breeding flock and to identify their ewe progeny as preferred genetics in the next generation of breeding ewes (Sheep CRC, 2014).

Chapter 5: Case study – Rotmell Farm, Scotland

Farming in the Hills near Pitlochry and Dunkeld in Scotland, Alex Brewster farms some rugged country, 80% consisting of windswept native heather hills. Alex runs 2,000 Scottish Black Face ewes on 2,500 hectares for prime lamb production. When Alex came home to the family property 12 years ago the flock was under-performing, with lamb marking percentages of 70% and a flock which was clearly struggling on the terrain where they were run.

Alex began his breeding programme back in 2001, where his motto of "Managed Natural Selection" was put into practice. Alex sourced his ewe nucleus flock from existing older ewes on the property, selecting those ewes which were able to rear good lambs to weaning on the heather hill country. Alex felt that it was important to retain those already adapted genetics in his nucleus flock to move his whole flock forward. Alex runs a five-family nucleus made up of ewes that are "survivors" and has a strict culling regime, based on reproductive performance and lamb growth rate. He is also very focused on selecting a lighter, 55 kg ewe to optimise his ewe efficacy. Alex also selects for worm resistance using the novel approach of leaving tails on his nucleus ewes and culling those which are daggy.

In the 12 years since his ram breeding programme began he has increased his scanning percentage to 150% and his marking percentage to 124%. Alex is resigned to accepting this reproductive wastage, as his ewes lamb outdoors, often in extreme weather such as snow on the hills. Growth rates have also improved with growth rates of 250 grams per day being achieved in 12 week old lambs on native and heather pastures.

The Rotmell farm story is a good example of the importance of adaptation and culling, and capitalising on genetics which are already in your flock. As Alex says "*the best adapted and performing animals for your environment are in your flock already, it is just a matter of identifying them"*(A. Brewster, Pers.Comm., July 2013)

Photo 7: Scottish Blackface ewes and lambs on hill country, Rotmell Farm Source: C Buttrose July 2013.

Photo 8: Alex Brewster overlooking the lowland area of Rotmell farm Source: C Buttrose July 2013.

Conclusion

As an industry we need to address the high level of reproductive waste currently occurring in our national sheep flock. Whilst there are significant differences between the climates and production systems of Australia and countries such as the UK and NZ, the fundamental importance of nutrition is the same. Optimising the reproductive potential of our national ewe flock is a process of adapting management practices and selection criteria to make incremental increases in lamb marking percentages. However, ewe nutrition during pregnancy is the key area for immediate attention. Meeting the nutritional needs of sheep in Australia is more difficult than other countries due to our climate but this study has shown that the cost of feeding ewes to requirement will be returned easily by improvements in lamb survival, farm productivity and income.

Lamb survival and increased reproductive efficiency in the sheep is a complex issue and there is not one single management practice to solve the issues that sheep producers face in this area. Usually poor reproductive performance is only measured at marking time, however, there have been six months of management decisions which have led to this poor result. Inclement weather at the time of lambing has often been blamed for poor reproductive outcomes and decreased lamb survival and this study has shown that there is a plethora of explanations for this outcome. It begins with breed selection and prolificacy and encompasses the environment and its influence on sheep breeding seasons, nutrition both at joining and during pregnancy, and includes the effect of trace element deficiencies. The genetic potential of a ewe with regard to her maternal ability coupled with selection for these better mothers is also highly significant in determining reproductive outcomes.

As technology advances, particularly in the areas of DNA markers and assisted selection and the on farm management tools available to identify superior animals within a flock, sheep producers will be able to harness the genetic potential which is already present in their flock.

Recommendations

- While selection for mothering ability is not practical for commercial producers, ram breeders can score ewes at lambing and offer rams from good mothers. Ideally ram breeders would incorporate this information into a maternal ability EBV for their clients to use when purchasing rams to breed replacement ewes.

- Evaluate the maternal breed and assess whether it is capable of providing the fertility and prolificacy you are targeting in your flock.

- Identify and prioritise multiple lambing ewes for nutrition, shelter and late pregnancy feeding. It is recognised by both academics and producers worldwide that lambs which are part of a multiple litter are much more likely to suffer poor survival than a single lamb.

- Consider feeding a high energy feed source in the last week of gestation to maximise colostrum production.

- Cull poor performing mothers and those which require assisted lambing. In a commercial flock this is possible through culling 'dry' ewes at scanning and culling 'dry' ewes at weaning (by udder inspection).

- Consider the importance of selecting animals which have been bred for and survive in your environment. There is more genetic variation within a breed than between breeds and the genetically elite animals are in your flock already. Breeding your own replacements for your own environment is imperative to success.

- Evaluate time of joining/lambing, with consideration to both the feed on offer for lambing ewes and the natural breeding cycle of the breed. Lamb survival increases when ewes have appropriate feed on offer, which is usually in spring.

- Producers need to begin accurately recording and benchmarking their reproductive performance. This is the only way to identify if management changes are having an impact on their flocks reproductivity.

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Plain English Compendium Summary

Project Title:	Optimising the reproductive potential of sheep production systems
Nuffield Australia Project No.:	1308
Scholar:	Carly Buttrose
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Objectives	To identify management practices from producers around the world to optimise the reproductive performance of the Australian prime lamb producing ewe flock with particular regard to improving lamb survival.
Background	The current Australian national average lamb marking percentage is 79% and has remained at this level for the past 30 years. The 'reproductive wastage' this causes is of significant loss of profit for lamb producers as well as an animal welfare issue.
Research	Major sheep producing countries, including the United Kingdom, New Zealand, Chile and Uruguay, were visited and both academics and farmers were interviewed in regards to their industry and management practices.
Outcomes	This study revealed that all countries face the same issues, where nutrition is the overarching contributor to reproductive efficiency. The adequate nutrition of multiple lamb rearing ewes was found to have the largest influence on lamb survival. The importance of selection of maternal and fertility traits in ewes was also recognised as an important factor.
Implications	The current national lamb marking percentage is quite low, the implications of improving this even by a small margin will result in increased profitability to producers and an improved welfare outcome for our animals.
Publications	