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Improving twin lamb survival with temporary fences

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Abstract

Improving lamb survival has been and continues to be a key priority for the Australian sheep and wool industry. Peri and postnatal lamb mortality is estimated to cost in excess of $A500 million per annum (Lane *et al* 2015).

Despite advances in technology and sheep management it is estimated that around 20% of lambs born in Australia still die prior to lamb marking (Allworth *et al* 2017) and the majority of lamb losses occur within the first three days of birth (Brien *et al* 2009). Starvation and mis-mothering account for the single highest cause of death representing around 25% of all deaths (Refshauge *et al* 2016).

This trial investigated the use of temporary fencing as a measure to reduce twin ewe mob size at lambing to reduce mismothering and improve lamb survival rates. Results over three years demonstrated that reducing mob size at lambing improved survival rates by 4.8%, and yielded a 'worst case' return of $2.70 for every $1 invested in fencing materials and construction. This work demonstrates that in addition to pre-lambing ewe condition score, shelter and feed on offer, achieving smaller mob sizes at lambing improves lamb survival, alleviates welfare concerns and improves on-farm profitability.

Executive summary

Improving lamb survival on commercial sheep properties in Australia is often limited by paddock size and the effective and optimal allocation of twin bearing ewes to lambing paddocks. There are multiple variables producers regularly contend with; feed on offer (FOO), shelter, topography, aspect and the lambing history of the paddock. Paddocks that fit the above criteria are often limiting in one or more aspects resulting in compromises to lambing management. For example, larger mobs of twins are lambed together to take advantage of the limited paddock availability or twin ewes are allocated to substandard paddocks resulting in lower potential lamb survival rates. Furthermore, not all paddocks are available for grazing or for ewes to lamb on, further complicating the effective allocation of ewes to lambing paddocks.

The aim(s) of this trial were:

1. To demonstrate a 10% improvement in twin lamb survival by reducing mob and paddock size with temporary fences during lambing
2. Demonstrate the cost-benefit of using temporary fences and the ease of construction and removal

This trial was conducted on Merino ewes (3/4 properties) and Composite ewes (one property for one year) across four properties in the Willaura/Lake Bolac areas of western Victoria between 2017-2019.

The experimental design was such that four paddocks on each farm were utilised for the trial;

- Paddock one – Traditional. Producer could chose paddock, stocking rate and mob size
- Paddock two – 8 ewes/ha with NO FENCE
- Paddock three – 8 ewes/ha with a temporary fence to halve mob size
- Paddock four – 6 ewes/ha with a temporary fence to halve mob size

In year two and three, the trial design was modified so that two different stocking rates (mob sizes) could be directly compared to each other as follows:

- Paddock one – 8 ewes/ha no fence
- Paddock two – 8 ewes/ha with a temporary fence to halve mob size
- Paddock three – 6 ewes/ha no fence
- Paddock four – 6 ewes/ha with a temporary fence to halve mob size

Over the life of the trial, there was a 4.8% improvement in lamb survival across the three participating properties. There was a significant difference (P=0.050) in survival between split and un-split paddocks. Pre-lamb ewe condition score significantly affected lamb survival outcomes (P=0.014) but paddock feed on offer had no impact on survival (P=0.716).

It is likely that the variation in survival response between years and across properties was caused by a combination of management practices and seasonal influences, given the geographical spread of properties enrolled in this trial. In addition, it was possible that lambs were able to move across the temporary fences and not find their way back, creating some mismothering and possible mortality. Mid pregnancy condition score has also been shown to influence lamb survival (Dwyer *et* al 2003) and this variable was not measured in this trial.

Over the trial period there were a total of 309 additional lambs born in paddocks that were subdivided with a temporary fence. When valued at $65/head, this represented an additional $20,085 income for a total outlay of $5007.30 in fencing materials, representing a 301% return on

investment over the trial period.

The average cost of erecting the fences per year equated to $1.14 per ewe or $8.65 per hectare, whilst the total net benefit over the trial period was $2.78 per ewe, $20.73 per hectare and $15.06 per lamb.

A partial budget was developed to investigate the returns on the capital outlay of the fence using a discount rate of 3.5% and a salvage value equivalent to 60% of the depreciated fence value after three years. The net present value (NPV) and internal rate of return (IRR) were calculated for each farm at the two different mob sizes over the three year trial. The lowest NPV across all sites over three years was $1591 and the lowest IRR was 41%, while the average cost: benefit ratio at the higher mob size of 8 ewes/ha averaged 5.2:1 (range 2.91 to 9.2) and at the lower mob size stocked at 6 ewes/ha averaged 2.96:1 and ranged from 2.7 to 3.23.

Applying a lifespan of ten years for the fencing materials with no salvage value after ten years increased the average cost benefit to 17:1 (range 5.22 to 25) for the higher mob size and 8:1 for the lower mob size (range 3.96 to 12.7). Whilst the benefit cost ratio was lower in the smaller mob size (6 ewes/ha) compared to the higher mob size (8 ewes/ha), this was not unexpected as the total returns in the smaller mob sizes were lower due to less lambs born per hectare and fewer lambs available to write off the fence cost.

A sensitivity analysis was conducted to investigate NPV returns in a 'worst case scenario' using data collected across the three year trial. The analysis used the highest fence cost of $1100, the lowest number of lambs surviving in any of the properties over the trial period (38) and a discount rate of 3.5%. The sensitivity analysis demonstrated that the largest driver of NPV was the number of extra lambs surviving rather than the value placed on each extra lamb surviving. For example, with the variables mentioned above, increasing the price per lamb from $65 per head to $70 per head increased the NPV by $96.62 while increasing the number of lambs surviving from 20 to 25 increased the NPV by $314.01.

The current industry guidelines recommend maximum mob sizes of 200 twin bearing ewes at lambing. This work demonstrated a linear relationship between mob size and survival with a decline in twin lamb survival of 3.4% for every additional 100 twin ewes in the paddock. These findings highlight that greater lamb survival can be achieved by reducing lambing ewe mob sizes to as low as practical and that temporary fences are a cost effective strategy to help producers achieve improved lamb survival outcomes with a net benefit of $2.78 per ewe or $20.73 per hectare.

As a result of these findings, the four core producers (100%) directly involved in this trial have changed or modified their lambing management strategies to now include temporary fences combined with smaller mob sizes at lambing. At least 50% of the observer producers in the region have adopted the use of temporary fences and reduced mob size at lambing and the remaining 50% of observer producers indicated that they would reduce mob size at lambing as a result of this trial.

Purchasing the fencing materials and using the temporary fence over a 10 year period provides a minimum return of $8 in extra lamb survival for every $1 spent on the fencing materials but can be as high as $17 dependant on the lamb survival rate.

The use of temporary fences should be part of an integrated approach to improving lamb survival.

Following industry guidelines such as the Lifetime Wool research combined with reducing mob sizes at lambing will collectively improve lamb survival, industry welfare standards and on-farm profitability.

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1 Background

1.1 Willaura Best Wool Best Lamb Group

The Willaura Best Wool Best Lamb (BWBL) group is a farmer discussion group formed in 2015 with the aim of increasing sheep productivity and improving livestock production systems through evidence based science and research. The group comprises 20 individual mixed farming businesses with a geographical spread throughout the Mininera and western districts of Victoria. The members are predominately mixed cropping/sheep focused, and conservatively run in excess of 130,000 breeding ewes across 80,000ha. These producers encompass both corporate and large scale private enterprises (incorporating stud rams, prime lamb and wool production) and are considered locally as key opinion leaders in their respective fields. A fundamental characteristic of the group is their innovative and forward thinking nature and their ability to identify opportunities and areas of improvement in their farming operations. The producers in this group strive for continued improvements in productivity and profitability and have the ability to influence other sheep producers throughout southwest Victoria and the Wimmera regions.

Of the 20 growers in the group, approximately 40% run a Merino breeding enterprise and 60% run a cross bred or composite enterprise. Of the 40% Merino operations, around half of those are considered specialist fine wool growers with traditional bloodlines (Merryville) while the balance run broader wool types typically >19µm and are actively selecting more modern genetics.

The Willaura / Lake Bolac regions of Victoria are renowned for cropping, prime lamb and wool. The rainfall pattern is winter dominate and average annual rainfall in the district ranges from 540mm at Lake Bolac to 510mm at Tatyoon (30km NE of Lake Bolac) and 550mm at Willaura (25km NW of Lake Bolac).

1.2 Improving lamb survival

Approximately 90% of group members have completed the Lifetime Ewe Management (LTEM) course and have made significant management changes as a result of their participation. For example, group members are proficient in feed budgeting and pasture assessment and have improved their lamb survival over the past 3-5 years by managing ewe condition and pasture targets. Although significant improvements in survival have been/continue to be made, a key reoccurring question was how to implement this knowledge into a mixed cropping/sheep enterprise in a cost effective manner. The producers had several challenges:

1. Each farm had >60-70% of their land area with paddocks >40ha
2. The area dedicated to winter cropping changed each year through a series of rotations
3. Traditionally, cropping yielded greater gross margins and returns per hectare compared to sheep and so there were capital outlay considerations in the sheep enterprise
4. Paddock subdivision with permanent fencing is costly and difficult as pastures are typically not considered permanent
5. Crops have not traditionally been grazed by sheep although this has changed dramatically in the past 2-3 years

Collectively, the group were in agreement that they were compromising lamb survival due to reduced paddock availability and the need to lamb larger mobs of twin ewes together. Due to the fact that the cropping rotations were set for a period of 4-5 years, the members discussed how they could work on their existing lambing paddocks to reduce the mob size. The concept of Precision Lambing was in its infancy (short joining periods of 14-17 days, scanning for early and late and re-using twin paddocks twice) and group member interest in this new management system was high, however the general consensus was that the collective group could still make management adjustments to their existing enterprise rather than change the enterprise completely. It was decided to investigate the use of temporary fences to enable larger paddocks to be split in half in order to reduce mob size at lambing and to ascertain if this translated to more twin lambs surviving as a result.

2 Trial objectives

The objective of this trial was to demonstrate to the members of the Willaura BWBL group an improvement in twin lamb survival where temporary fences were constructed to reduce twin ewe mob size at lambing and for 20% of group members and 20% of the broader farming community exposed to the work to engage in the practice of fencing for improved twin lamb survival. The second component of this trial was to look at the cost of fencing construction and materials to ascertain if there was a financial benefit for time and effort invested. The third component of this work was to disseminate the findings to the broader farming community through producer case studies, field days, media coverage and presentations.

2.1 Aims

The aims of the trial were to:

1. Demonstrate how temporarily reducing paddock and twin ewe mob size during lambing with a temporary fence can increase twin lamb survival by 10% (measured by marking percentage relative to mob allocation to paddock).
2. Demonstrate the ease at which temporary fences can be constructed and removed
3. Provide a cost/benefit analysis on the use of temporary fences

3 Methodology

3.1 Trial Design

3.1.1 Site selection and producer involvement

Producer involvement and selection was decided during a BWBL meeting. Four group members volunteered their properties as sites for the trial and of the four sites selected; three sites ran Merino ewes, while the fourth site ran composite ewes. The fourth site was only involved for the first year of the trial before the property was sold.
The location of the four properties were:
Tatyoon, VIC
Willaura, VIC
Willaura, VIC
Moyston, VIC (first year only)

3.1.2 Management/Steering Committee

A management committee was established consisting of three producer participants and the trial manager (Steve Cotton) to review the trial and paddock designs. Meetings were held twice yearly – one meeting eight weeks prior to lambing to review the previous year's design and results so that any necessary changes could be made and the second meeting post lamb marking to review results. The management committee agreed to and set the paddock stocking density as well as mapping paddocks to ensure accurate paddock sub-division.

3.1.3 Paddock Design Year 1

It was noted by the steering committee that it would be difficult to compare trial results between farms due to differences in time of lambing, paddock sizes, genetics, feed on offer and shelter. However, direct comparisons between paddocks on each farm over the three year trial could be compared and analysed. It was also noted that the trial had to consider the commercial nature of each business and as such, exact paddock sizes within and between farms would not always be possible.

Following due consultation, each producer participant selected four paddocks for use in the trial. These had to be paddocks where they had traditionally lambed twin bearing ewes in previous years.

The paddocks were set up as follows and are summarised in Figure 1:

1. Paddock 1: (Negative control): "Traditional" stocking rate. Ewes stocked at each farmers traditional stocking rate
2. Paddock 2: Twin bearing ewes stocked at 8 ewes/ha. Paddock NOT subdivided
3. Paddock 3: Paddock subdivided in half with a temporary fence and each half stocked at 8 ewes/ha
4. Paddock 4: Paddock subdivided in half with a temporary fence and each half stocked at 6 ewes/ha

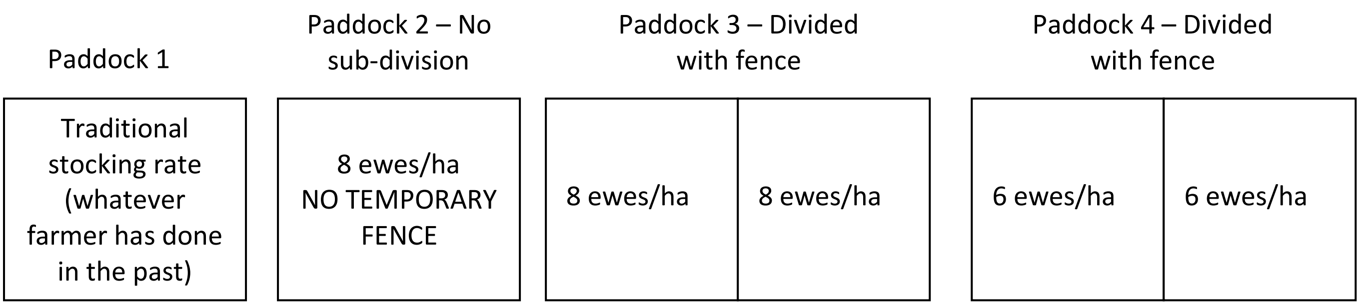

Fig.1 – Design of paddock plan in year one of the trial

3.1.4 Paddock Design Year 2 & 3

Following a review of paddock design after the first year of the trial it was decided to remove the "traditionally stocked paddock" and provide a positive control at 6 ewes/ha with no subdivision (Figure 2) so direct comparisons could be made at the lower stocking rate treatment as follows:

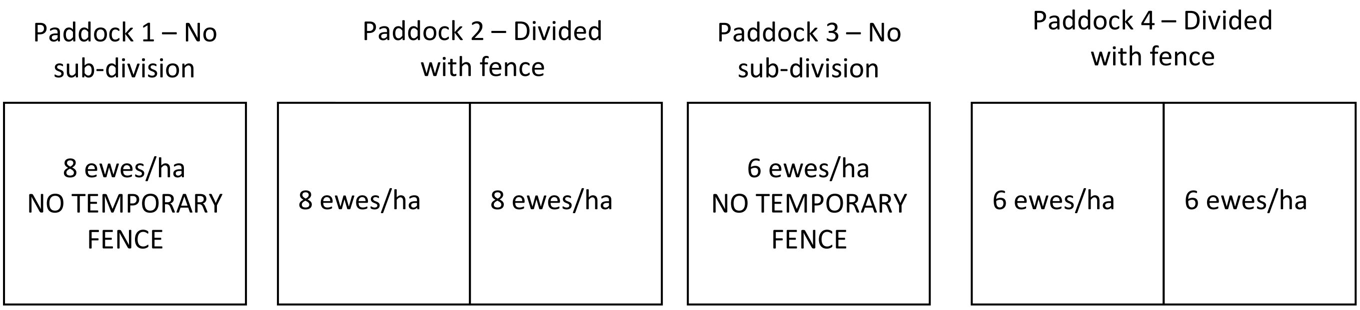

Fig.2 – Design of paddock plan in year two and three of the trial

Aerial views of individual paddock plans for each farm are shown in later sections (Figures 10-13) to provide context of shelter distribution across each paddock and the location of the paddocks used in the trial.

3.1.5 Fencing type and design

The fencing type and design was discussed at the commencement of the trial. Whilst no direct comparisons between fencing design and effectiveness were directly measured, it was decided that each farm would use different materials to provide some anecdotal advice on ease of construction and effectiveness of keeping ewes and lambs on their respective sides of the paddock. The cost of materials and construction were noted so that a cost-benefit could be completed at the end of each lambing. The types of fencing utilised in the trial are shown in Figures 3-9.

3.1.6 Fencing economic analysis

The cost of fencing each paddock during the trial was calculated by adding the material costs plus labour (@ $50/hr/person) for erection and disassembly.

Microsoft Excel® was used to create a partial budget to analyse the cost of the fencing versus the return (e.g. extra lambs surviving) to determine the present value of both benefits and costs to calculate the Net Present Value (NPV) and Internal Rate of Return (IRR) using the following assumptions:

1. A discount cash rate of 3.5% which is the 10 year average return for CPI indexed bonds representing virtually no risk relative to return)
2. The value of an extra lamb surviving being $65 per head
3. A salvage value equivalent to 40% of the initial capital outlay (depreciated by 20% per year (60% over the 3 years) for the life of this trial

The benefit cost ratio was calculated by dividing the total present costs into the total present values.

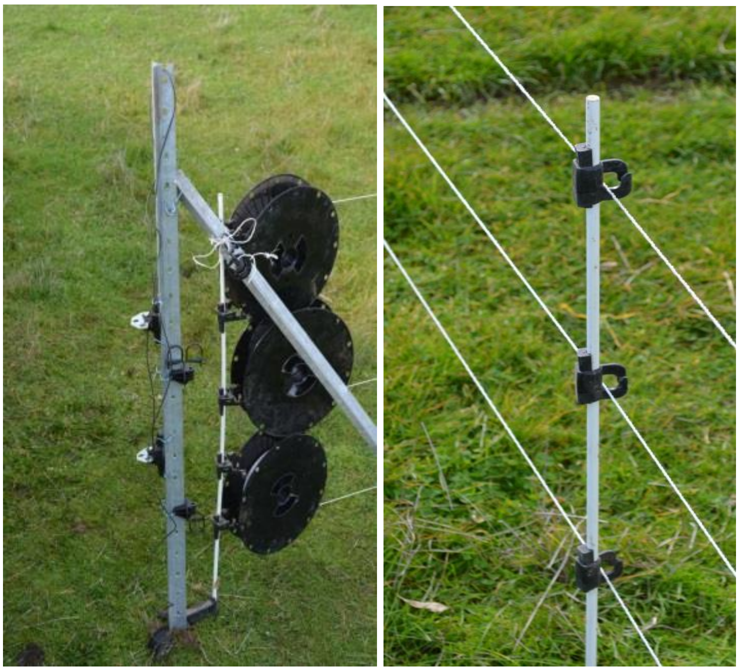

Fig.3 – Design of fence one incorporating a combination of galvanised star posts, three electric tapes

Fig.4 – Fence one after construction and insulated fibreglass tread ins spaced approximately 15m apart

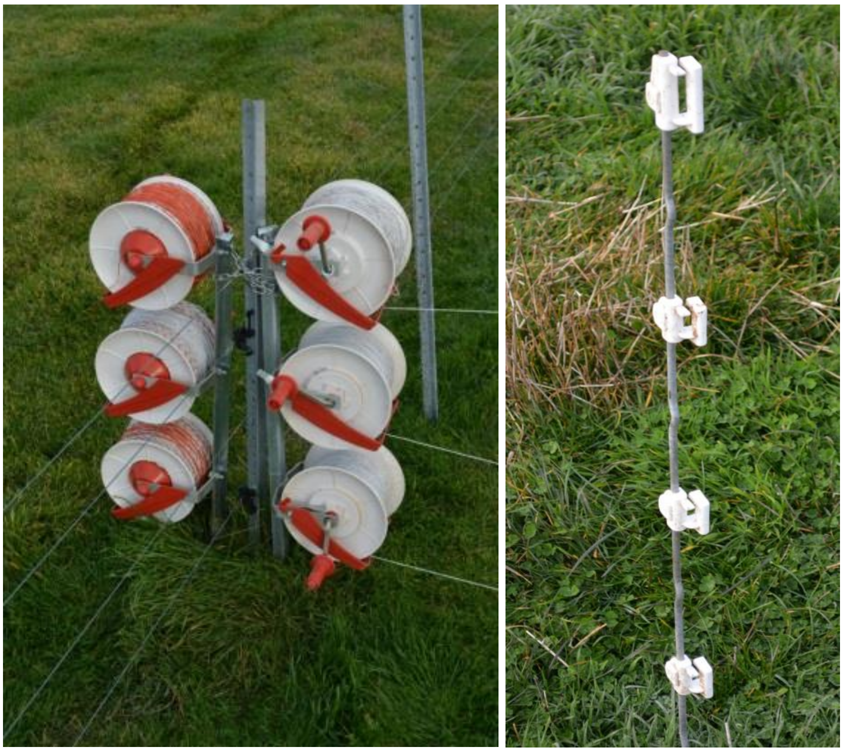

Fig.5 – Design of fence two incorporating a three electric tapes and insulated galvanised tread ins spaced approximately 10m apart

Fig.6 – Fence two after construction

Fig.7 – Design of fence three incorporating a combination of a permanent end assembly and gate, mains power a two plain wire system with plastic tread ins and galvalnised start posts

Fig.8 – Fence three after construction

Fig.9 – Design of fence four incorporating four plain wires (2 electrified) and galvanised start posts spaced 15m apart

3.1.7 Paddock Design of Farm 1 – Year 1

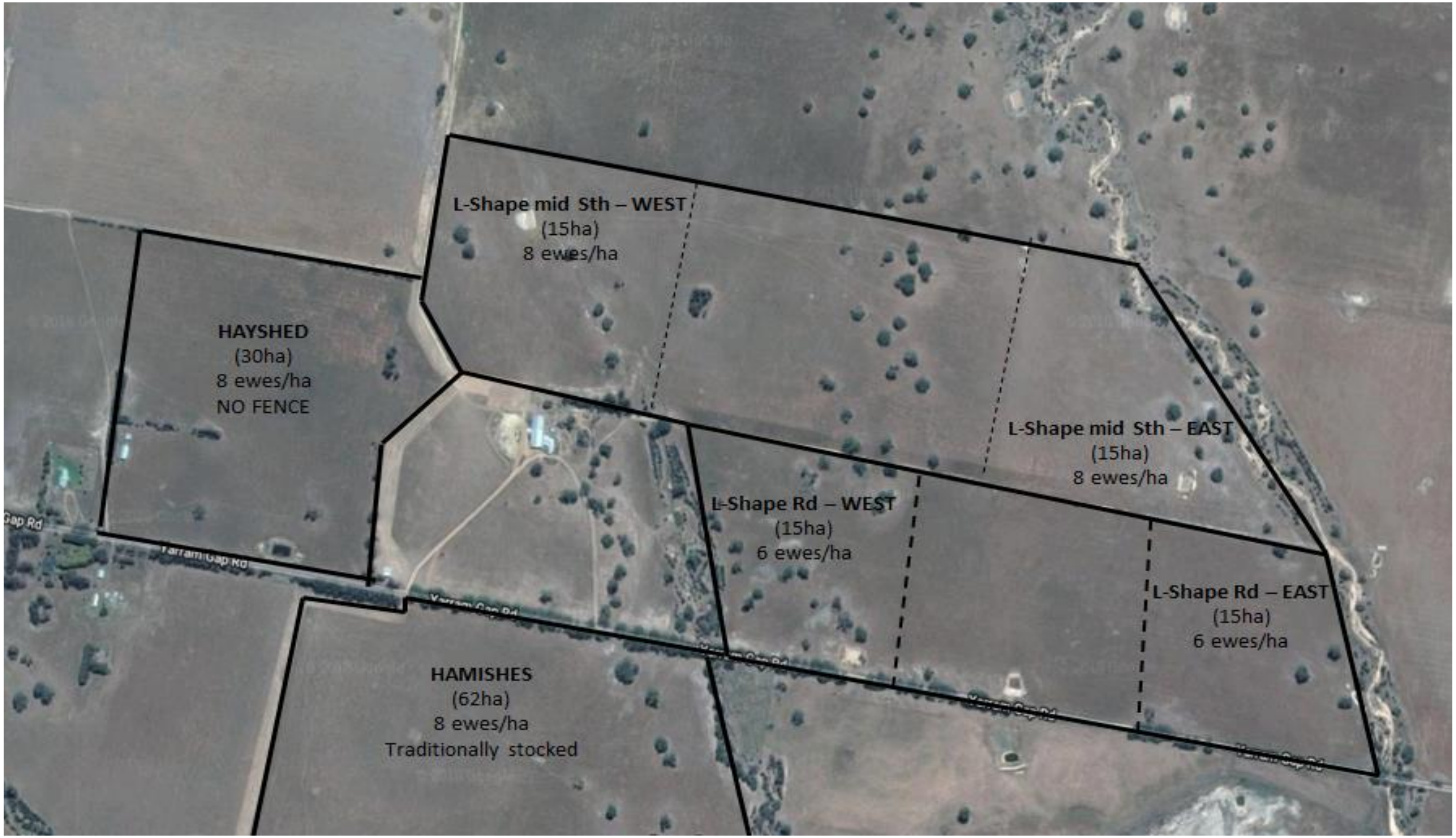

Fig.10 – Overview of paddocks and treatments on Farm one, year one (only year this farm participated in trial)

3.1.8 Paddock Design of Farm 2 – Year 1

Fig.11 – Overview of paddocks and treatments on Farm two.

3.1.9 Paddock Design of Farm 3 – Year 1

Fig.12 - Overview of paddocks and treatments on Farm three.

3.1.10 Paddock Design of Farm 4 – Year 1

Fig.13 – Overview of paddocks and treatments on Farm four.

3.1.11 Ewe and Pasture Management

Twin bearing ewes on each property were yarded at between day 130 and 140 of pregnancy. Each producer carried out their routine animal husbandry procedures (for example drenching and vaccination) as required. Ewes were condition scored (scale of 1-5) in a drafting/handling race and the average for each farm recorded. Ewes that were <2.5 condition score were omitted from the trial. The required number of sheep for each treatment (paddock) were counted and allocated after the sheep were randomly drafted through the handling race. The mob was then walked to the required paddock and the process repeated until all sheep had been randomly allocated to their respective paddocks.

Producers that would check and assist ewes lambing or feed ewes during pregnancy/lactation under normal management practises were permitted to continue however, they were required to check all mobs at the same time to minimise the potential effect of their interaction by not checking all mobs.

The producers kept records of ewe mortalities through the five week lambing period and any notes of events that might influence the results (for example, bad weather events) were noted.

Ewes and lambs from each treatment were counted at lamb marking and subsequent survival outcomes calculated as follows:

$$Lamb\ survival\ (\%) = \frac{\text{Number of lambs marked}}{\text{Potential number of foetuses at the start of lambing}}\ \text{x}\ 100\%$$

For paddocks subdivided with a fence, the total number of lambs from the paddock (eg lambs from both sides of the fence) was added together to compare survival rates of lambs born in the paddock with no subdivision as shown in Figure 14.

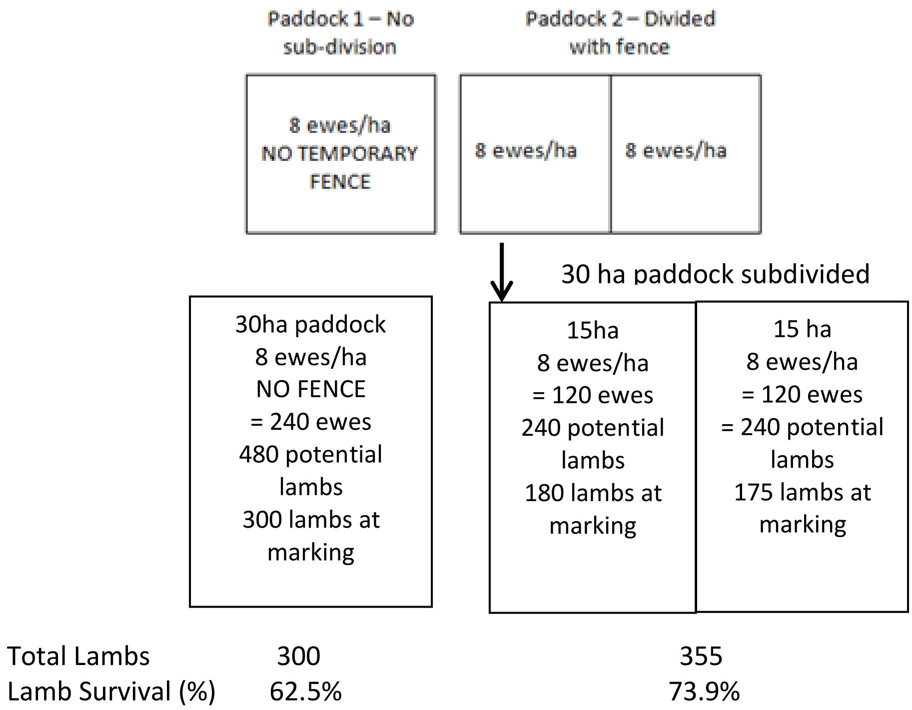

Fig.14 – Diagrammatical representation of how lamb survival was calculated between treatment groups

Pasture Feed on Offer (FOO) (kg/DM ha) was assessed at 25 random locations in each paddock on each farm at day 130-140 of pregnancy and again at lamb marking. Observations of botanical composition (quality) and variety were recorded.

Further information on shelter, topography and aspect were noted for each paddock at the beginning of the trial. The aerial maps in shown in figures 10-13 offer some perspective on shelter distribution for each of the paddocks analysed.

3.1.12 Data and Statistical Analysis

Data analysis was conducted using Microsoft Excel®. Direct comparisons of survival were made between like treatment groups within farm and between years. Financial comparisons including net present value (NPV), internal rate of return (IRR), and cost-benefit and sensitivity analysis were also conducted using Microsoft Excel®.

Lamb survival was assessed using the method of restricted maximum likelihood (GenStat 2018). Treatment (split and non-split), ewe condition score and feed on offer were fitted as fixed effects. The random terms fitted were year, farm (nested within year) and plot (nested within farm). To determine the linear effect of mob size, from the above analysis all significant fixed terms were retained with the mob size actual values replacing the treatment levels within the same mixed model structure.
The influence the random effects had on lamb survival were considered statistically significant at $P<0.05$.

4 Results

4.1 Year 1

There were four separate treatments during Year one;

1. Paddock 1 (Negative control): “Traditional” stocking rate. Ewes stocked at each farmers traditional stocking rate
2. Paddock 2: Twin bearing ewes stocked at 8 ewes/ha. Paddock NOT subdivided
3. Paddock 3: Paddock subdivided in half with a temporary fence and each half stocked at 8 ewes/ha
4. Paddock 4: Paddock subdivided in half with a temporary fence and each half stocked at 6 ewes/ha

Direct comparisons can only be made against paddock 2 and paddock 3 due to the fact that paddock size and stocking rate between these two paddocks were similar and the only variable was the mob size.

Farm one participated for the first year of the trial and was the only enterprise in the trial that ran Composite ewes. The results show 67.3% survival (134.6% lambs marked) in the un-split paddock and an average survival of 75.8% (151.7% lambs marked) when the mob size was halved (Table 1). This represents a survival improvement of 8.5% by halving mob size with a temporary fence or an extra 1.4 lambs per hectare.

Table 1. Summary lamb survival data from farm one in year one

Treatment	Paddock size (ha)	SR (ewes/ha)	Ewe mob size	No. lambs	Lamb survival (%)	Marking %	Extra lambs/ha
NO SPLIT	30	8	240	323	67.3	134.6	0
SPLIT	30	8	240	364	75.8	151.7	41

Further improvements in survival were evident when the stocking rate (and mob size) was lowered to 6 ewes/ha. Survival in this treatment group was 82.7% or 165.5% lambs marked which represents an improvement of 6.9% survival compared to 8 ewes/ha with a fence. The full results by paddock are contained in Appendix 8.1.1.

The results of farm two show 60.3% survival (120.6% lambs marked) in the un-split paddock and an average survival of 57.2% (114.4% lambs marked) when the mob size was halved (Table 2). This represents a reduction in survival of 3.1% by halving mob size with a temporary fence.

Table 2. Summary lamb survival data from farm two in year one

Treatment	Paddock size (ha)	SR (ewes/ha)	Ewe mob size	No. lambs	Lamb survival (%)	Marking %	Extra lambs/ha
NO SPLIT	20	8	160	193	60.3	134	0
SPLIT	20	8	160	183	57.2	114.4	-10

There were further improvements in survival when the stocking rate (and mob size) was lowered to 6 ewes/ha. Survival in this treatment group was 63% or 126% lambs marked, representing an improvement of 5.8% survival compared to 8 ewes/ha with a fence. The full results by paddock are contained in Appendix 8.1.2

The results of farm three show 51.1% survival (102.2% lambs marked) in the un-split paddock and an average survival of 54.9% (110% lambs marked) when the mob size was halved (Table 3).

Survival in the lower mob (6 ewes/ha) treatment group was 68% or 136% lambs marked which represents an improvement of 13.1% survival compared to 8 ewes/ha with a fence.

Table 3. Summary lamb survival data from farm three in year one

Treatment	Paddock size (ha)	SR (ewes/ha)	Ewe mob size	No. lambs	Lamb survival (%)	Marking %	Extra lambs/ha
NO SPLIT	22	8	176	180	51.1	102.2	0
SPLIT	25	8	200	219	54.9	110	39

The full results by paddock are contained in Appendix 8.1.3.

The results of farm four show 64.2% survival (128.4% lambs marked) in the un-split paddock and an average survival of 69.2% (138% lambs marked) when the mob size was halved.

Table 4. Summary lamb survival data from farm four in year one

Treatment	Paddock size (ha)	SR (ewes/ha)	Ewe mob size	No. lambs	Lamb survival (%)	Marking %	Extra lambs/ha
NO SPLIT	15	8	120	154	64.2	128.4	0
SPLIT	15	8	120	166	69.2	138	12

Further improvements in survival were evident when the stocking rate (and mob size) was lowered to 6 ewes/ha (Table 4). Survival in this treatment group was 71.6% or 143.3% lambs marked which represents an improvement of 2.4% survival compared to 8 ewes/ha with a fence.

The full results by paddock are contained in Appendix 8.1.4.

The lamb marking results from each property is summarized in Table 5 below. The results indicate a high level of variability within the year between the four properties enrolled. The survival rates were calculated by halving the difference in lamb marking rates between split and not-split treatments. Overall there was a 3.5% improvement in lamb survival by using a temporary fence to halve mob at lambing.

4.1.1 Summary Year 1

The lamb marking results from each property is summarized in table 5. The results indicate a high level of variability within the year between the four properties enrolled. Overall there was a 7% improvement in lamb survival by using a temporary fence to halve mob at lambing.

Table 5. Summary results of year one showing the differences in lamb marking rates between each property

	NO SPLIT	SPLIT	Difference
Farms			
Farm 1	135	152	+17
Farm 2	121	114	-7
Farm 3	102	110	+8
Farm 4	128	138	+10
Average Year 1	**121**	**128**	**+7**

4.2 Year 2

Three farms participated in year two of the trial. Modifications to the methodology allowed comparisons of two treatment groups;

1. 8 ewes/ha with and without subdivision
2. 6 ewes/ha with and without subdivision

The results of farm two show 60.25% survival (120.5% lambs marked) in the un-split paddock and an average survival of 60.95% (121.9% lambs marked) when the mob size was halved (Table 6). This represents an in improvement in survival of 0.7% by halving mob size with a temporary fence.

At 6 ewes/ha, survival with no subdivision was 57.9% compared to 66.6% with subdivision, representing an improvement of 8.7% or 17.4% more lambs marked.

Table 6. Summary lamb survival data from farm two in year two

Treatment	Paddock size (ha)	SR (ewes/ha)	Ewe mob size	No. lambs	Lamb survival (%)	Marking %	Extra lambs/ha
NO SPLIT	25	8	200	241	60.25	120.5	0
SPLIT	20	8	200	195	60.9	121.9	-46.0
NO SPLIT	20	6	120	139	57.9	115.8	0
SPLIT	20	6	120	160	66.6	133.3	21.0

The full results by paddock are contained in Appendix 8.1.2.

The results of farm three show 62.8% survival (125.6% lambs marked) in the un-split paddock and an average survival of 65.9% (131.8% lambs marked) when the mob size was halved (Table 7). This represents an in improvement in survival of 3.1% by halving mob size with a temporary fence.

At 6 ewes/ha, survival with no subdivision was 63.6% compared to 71.6% with subdivision, representing an improvement of 8% or 16% more lambs marked. The full results by paddock are contained in Appendix 8.1.3.

Table 7. Summary lamb survival data from farm three in year two

Treatment	Paddock size (ha)	SR (ewes/ha)	Ewe mob size	No. lambs	Lamb survival (%)	Marking %	Extra lambs/ha
NO SPLIT	18	8	144	181	62.8	125.6	0
SPLIT	25	8	200	264	65.9	131.8	83.0
NO SPLIT	22	6	132	168	63.6	127.2	0
SPLIT	20	6	120	172	71.6	143.3	4.0

The results of farm four show 67.1% survival (134.2% lambs marked) in the un-split paddock and an average survival of 68.8% (137.5% lambs marked) when the mob size was halved (Table 8). This represents an in improvement in survival of 1.7% by halving mob size with a temporary fence.

At 6 ewes/ha, survival with no subdivision was 72.8% compared to 83.3% with subdivision, representing an improvement of 10.5% or 21% more lambs marked. The full results by paddock are contained in Appendix 8.1.4.

Table 8. Summary lamb survival data from farm four in year two

Treatment	Paddock size (ha)	SR (ewes/ha)	Ewe mob size	No. lambs	Lamb survival (%)	Marking %	Extra lambs/ha
NO SPLIT	15	8	120	161	67.1	134.2	0
SPLIT	15	8	120	165	68.8	137.6	4.0
NO SPLIT	15	6	90	131	72.8	145.6	0
SPLIT	15	6	90	150	83.3	166.7	19.0

4.2.1 Summary Year 2

The lamb marking results from each property are summarized in table 9 below. The results indicate a high level of variability throughout the year and between the four properties enrolled. Overall there was a 5.5% improvement in lamb survival by using a temporary fence to halve the mob size at lambing.

Table 9. Summary results of year two showing the differences in lamb marking rates between each property and at two different mob sizes

	NO SPLIT	SPLIT	Difference
Farms			
Farm 1	Didn't participate in Year 2		
Farm 2 (8 ewes/ha)	120.5	121.9	+1.4
Farm 2 (6 ewes/ha)	115.8	133.3	+17.5
Farm 3 (8 ewes/ha)	125.7	132.0	+6.3
Farm 3 (6 ewes/ha)	127.3	143.3	+16.0
Farm 4 (8 ewes/ha)	134.2	137.5	+3.3
Farm 4 (6 ewes/ha)	145.6	166.7	+21.1
Average Year 2	**128.2**	**139.1**	**+10.9**

4.3 Year 3

The results of farm two show 60.3% survival (120.6% lambs marked) in the un-split paddock and an average survival of 58.5% (117% lambs marked) when the mob size was halved (Table 10). This represents a reduction in in survival of -1.8% by halving mob size with a temporary fence.

There was no data captured at the lower stocking rate due to management issues. The full results by paddock are contained in Appendix 8.1.2.

Table 10. Summary lamb survival data from farm two in year three

Treatment	Paddock size (ha)	SR (ewes/ha)	Ewe mob size	No. lambs	Lamb survival (%)	Marking %	Extra lambs/ha
NO SPLIT	20	8	160	193	60.3	120.6	0
SPLIT	20	8	160	187	58.5	117	-6.0

The results of farm three show 67% survival (134% lambs marked) in the un-split paddock and an average survival of 68.7% (137.4% lambs marked) when the mob size was halved (Table 11). This represents an in improvement in survival of 1.7% by halving mob size with a temporary fence.

At 6 ewes/ha, survival with no subdivision was 65.9% compared to 69.8% with subdivision, representing an improvement of 3.9% or 7.8% more lambs marked. The full results by paddock are contained in Appendix 8.1.3.

Table 11. Summary lamb survival data from farm three in year three

Treatment	Paddock size (ha)	SR (ewes/ha)	Ewe mob size	No. lambs	Lamb survival (%)	Marking %	Extra lambs/ha
NO SPLIT	18	8	144	193	67.0	134	0
SPLIT	20	8	160	220	68.7	137.4	+27
NO SPLIT	22	6	132	174	65.9	131.8	0
SPLIT	25	6	150	209	69.8	139.6	+35.0

The results of farm four show 59.5% survival (119% lambs marked) in the un-split paddock and an average survival of 69.3% (138.7% lambs marked) when the mob size was halved (Table 12). This represents an in improvement in survival of 9.8% by halving mob size with a temporary fence.

At 6 ewes/ha, survival with no subdivision was 68.9% compared to 79.4% with subdivision, representing an improvement of 10.5% or 21% more lambs marked. The full results by paddock are contained in Appendix 8.1.4.

Table 12. Summary lamb survival data from farm four in year three

Treatment	Paddock size (ha)	SR (ewes/ha)	Ewe mob size	No. lambs	Lamb survival (%)	Marking %	Extra lambs/ha
NO SPLIT	15	8.8	132	157	59.5	118.9	0
SPLIT	15	8.8	132	183	69.3	138.6	+26
NO SPLIT	15	6	90	124	68.9	137.8	0
SPLIT	15	6	90	143	79.4	158.9	+19

4.3.1 Summary Year 3

The lamb marking results from each property is summarized in table 13 below. The results indicate a high level of variability within the year between the four properties enrolled. Overall there was a 4.9% improvement in lamb survival by using a temporary fence to halve mob at lambing.

Table 13. Summary results of year three showing the differences in lamb marking rates between each property and at two different mob sizes

	NO SPLIT	SPLIT	Difference
Farms			
Farm 1	Didn't participate in Year 3		
Farm 2 (8 ewes/ha)	120.6	117.0	-3.6
Farm 2 (6 ewes/ha)	No results available		
Farm 3 (8 ewes/ha)	134.0	137.4	+3.4
Farm 3 (6 ewes/ha)	131.8	139.6	+7.8
Farm 4 (8 ewes/ha)	118.9	138.6	+19.7
Farm 4 (6 ewes/ha)	137.8	158.9	+21.1
Average Year 3	**128.6**	**138.3**	**+10.4**

A summary of each year's trial results by farm and treatment is shown in Table 16.

4.4 Feed on Offer at lambing and pre-lamb ewe condition score

There was variation in FOO and ewe condition score both between and within farms and years. Feed on offer did not influence survival outcomes in this trial (*P* = 0.716) but ewe condition score had a significant influence on lamb survival (*P*=0.014). The feed on offer and ewe condition score data is shown in Tables 14 and 15.

Table 14. Average feed on offer (kg DM/ha) and pre-lambing ewe condition score for each farm across all years for mob sizes stocked at 8 ewes/ha

YEAR	FARM	TREATMENT	FOO (kg/DM/ha)	EWE CS
8 ewes/ha				
1	**1**	NO SPLIT	1380	3.3
		SPLIT	1250	
	2	NO SPLIT	2200	2.9
		SPLIT	2355	
	3	NO SPLIT	1430	2.9
		SPLIT	1265	
	4	NO SPLIT	1050	3.1
		SPLIT	1190	
2	**2**	NO SPLIT	1330	
		SPLIT	1476	3
	3	NO SPLIT	1525	3.2

		SPLIT	1432.5	
	4	NO SPLIT	1420	
		SPLIT	1410	3
3	2	NO SPLIT	840	
		SPLIT	995	3
	3	NO SPLIT	1930	
		SPLIT	1575	3.2
	4	NO SPLIT	1350	
		SPLIT	2062.5	3.3

Table 15. Average feed on offer (kg DM/ha) and pre-lambing ewe condition score for each farm across all years for mob sizes stocked at 8 ewes/ha

YEAR	FARM	TREATMENT	FOO (kg/DM/ha)	EWE CS
		6 ewes/ha		
1	1	NO SPLIT	N/A	3.3
		SPLIT	1550	
	2	NO SPLIT	N/A	2.9
		SPLIT	1865	
	3	NO SPLIT	N/A	2.9
		SPLIT	1325	
	4	NO SPLIT	N/A	3.1
		SPLIT	1340	
2	2	NO SPLIT	1420	
		SPLIT	946	3
	3	NO SPLIT	2080	
		SPLIT	1975	3.2
	4	NO SPLIT	1600	
		SPLIT	1767.5	3
3	2	NO SPLIT	No data	
		SPLIT		
	3	NO SPLIT	3000	
		SPLIT	2815	3.2
	4	NO SPLIT	1830	
		SPLIT	1110	3.3

4.5 Summary of all survival results by farm, treatment and year

Table 16. Summary trial results by year, farm and year x farm

	NO SPLIT	SPLIT	Survival Difference
Mean	63.2	68.0	+4.8
Years			
Year 1	60.7	64.3	+3.6
Year 2	64.1	69.5	+5.4
Year 3	64.8	70.1	+5.2
Farms			
Farm 1	67.3	75.8	+8.5
Farm 2	59.9	59.8	-0.1
Farm 3	60.2	64.3	+4.1
Farm 4	66.1	73.2	+7.1
Years by Farms			
Year 1 x Farm 1	67.3	75.8	+8.5
Year 2 & 3 x Farm 1	Did not participate in Year 2 or 3		
Year 1 x Farm 2	60.3	57.2	-3.1
Year 2 x Farm 2	59.1	63.7	+4.6
Year 3 x Farm 2	60.3	58.5	-1.8
Year 1 x Farm 3	51.1	54.9	+3.8
Year 2 x Farm 3	63.2	68.7	+5.5
Year 3 x Farm 3	66.4	69.2	+2.8
Year 1 x Farm 4	64.2	69.2	+5.0
Year 2 x Farm 4	69.9	76.0	+6.1
Year 3 x Farm 4	64.2	74.3	+10.1
@ 8 ewes/ha ALL YEARS	62.0	64.9	+2.9
@ 6 ewes/ha ALL YEARS	65.8	74.1	+8.3

4.6 The effect of ewe mob size at lambing on lamb survival

The effect of ewe mob size at lambing and lamb survival has a linear relationship so that as mob size decreases, lamb survival is increased (Figure 15). The response demonstrates that for every extra 100 ewes in the mob at lambing, survival is reduced by 3.4%.

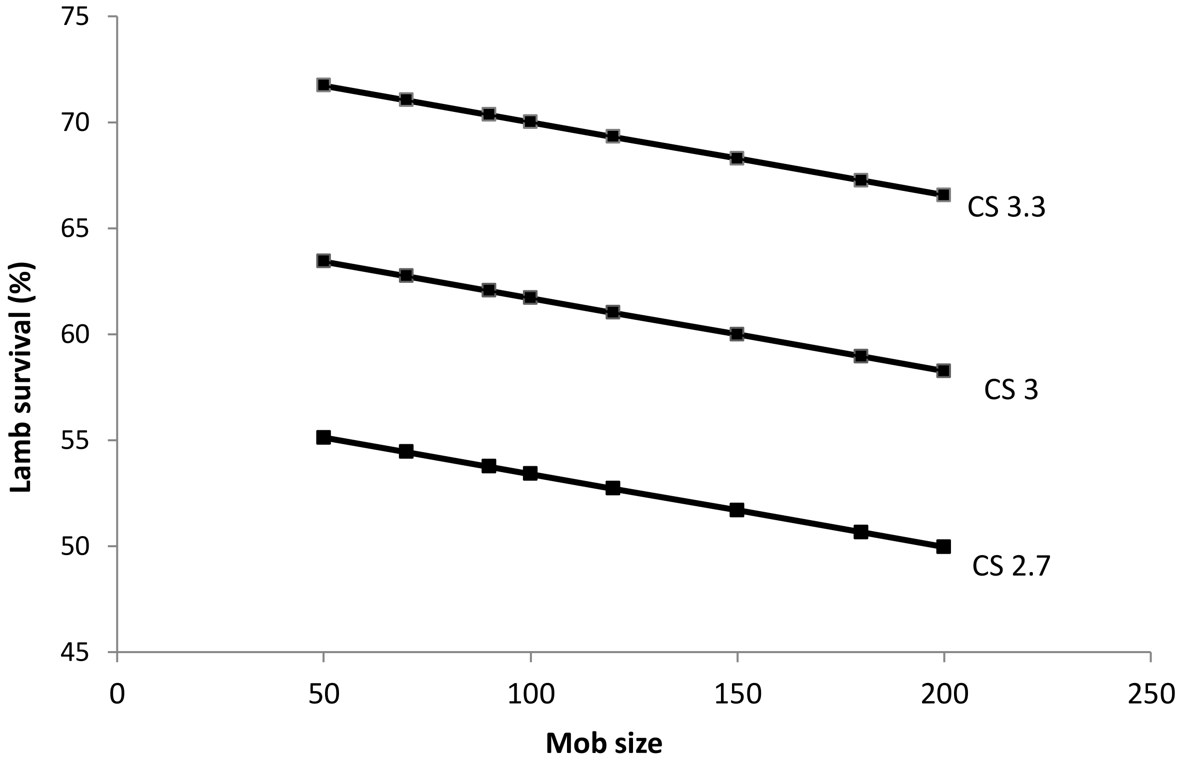

Fig.15 - The relationships between mob size, ewe condition and lamb survival for ewes enrolled in the trial

4.6.1 Statistical significance of the findings

Over the trial period, there was a significant difference in lamb survival between split and un-split mobs (Table 17). Ewe condition score had a significant effect on lamb survival, however feed on offer did not.

Table 17. The mean treatment effect (split Vs not-split) over three years on survival. Statistical significance of terms and interactions accepted at P < 0.05. N.S = Not Significant

	Split	Not split	L.S.D	P value
Treatment	61.99	64.93	2.94	0.050
Ewe condition score				0.014
Feed on Offer				N.S (0.716)

4.7 Financial Analysis

4.7.1 Costs and benefits per hectare, per ewe and per lamb

The total costs were calculated on a per ewe basis, a per hectare basis and a per lamb basis. The total benefit was calculated as the additional lambs surviving as a direct result of the paddock subdivision multiplied by $65 per lamb. The net benefit was calculated by subtracting the costs from the benefits as shown in table 18 below.

Table 18. Summary of financial analysis by farm over the three year period showing the net benefit on a per ewe, per hectare and per lamb basis

	Net benefit per ewe/year	Net benefit per ha/year	Net benefit per lamb/year
Farm 1	$2.25	$17.80	$13.03
Farm 2		Not reported in data set	
Farm 3	$4.02	$29.04	$17.77
Farm 4	$2.09	$15.36	$14.40
Average per year	$2.78	$20.73	$15.06
Total for trial	$8.34	$62.20	$45.19

There were a total of 309 additional lambs born in paddocks that were subdivided with a temporary fence. At a value of $65/head, this represents an additional $20,085 income for a total outlay of $5007.30 in fencing material. This represents a 301% return on investment over the trial period. The total net benefit per ewe was $8.34, $62.20 per hectare and $45.19 per ewe.

4.7.2 Types of fencing

The cost of fencing each paddock during the trial varied between sites and was dependant on the type of fencing material purchased for the trial. Farm one purchased Kiwitech fencing (Figure 16) that consisted of fibreglass rods and three electric tape reels. They already had the solar energizers on hand so this reduced the cost of fencing materials. Likewise, farm three already had electrified main fencing so were able to set up their temporary fencing off mains power. The additional costs associated with farm three compared to the others were due to the fact that they constructed permanent end assemblies that remained in the paddock all year. At lambing, they would simply swing a gate off the strainer and then construct the temporary fence.

Farm two used plastic tread in droppers and three electrified tape reels. Steel droppers were used as end assemblies and solar units were purchased specifically for the trial.

Farm four had the lowest initial capital of fence materials due to the fact that owner recycled wire and droppers from older fences that had been pulled down and so the costs were lower compared to buying the materials new. A summary of fence types and costs are shown in Table 19.

Table 19. Types of fences used throughout the trial including total costs and time to construct

Farm	Fence type	Total cost/paddock ($)	Time to construct (hours)*	Largest Area fenced (ha)
1	Kiwitech (fibreglass rods and 3 reel tapes) – all electrified	$1062.90	~ 3hrs	30ha
2	Speedrite (tread in plastic droppers and 3 reel tapes) – all electrified	$1000.00	~3hrs	20ha
3	Galvanised droppers and 2 plain wires (both electrified)	$1100.00	~2hrs	25ha
4	Galvanised droppers and 4 plain wires (2 electrified)	$872.20	~2.5hrs	15ha

* Labour charged at $50/hr/person and is included in the total cost

Fig.16 – The four different types of fences used throughout the trial

4.7.3 Cost of capital invested in fencing materials over the three year trial

The net present value and internal rate of return were calculated to assess the benefit cost ratio of using the temporary fencing. There is variability in the net return between farms based on

a. Initial capital outlay and therefore salvage value
b. The number of extra lambs surviving

The analysis shown in table 20 takes into account what rate of return each farmer could obtain for their capital invested on fencing material if they invested it into something else (opportunity cost) that yielded a 3.5% return (the discount rate). The net present value (NPV) looks at net cash inflow (extra lambs surviving) and cash outflow (cost of capital) over time (3 years) and the discount rate or return that could be earned in alternative investments. Positive NPV demonstrate the profitability of the capital invested.

Farm one, three and four all had positive NPVs, although they varied based on the number of extra lambs that survived as a result of using the temporary fence. The higher the lamb survival rates relative to initial fence cost, the greater the return in value. Farm two failed to realise the economic return from fencing due to their poor lamb survival and high ewe mortality relative to the un-fenced control paddocks and hence lost money on their investment (Table 20). The internal rate of return (IRR) looks at what discount rate is required for the NPV to equal zero - or in other words, for an alternative investment what rate of return they would need to generate to make the alternative a better investment.

Table 20. The cost-benefit of using temporary fences to achieve greater lamb survival (mob size when ewes stocked at 8/ha) as calculated the initial capital investment discounted at 3.5% annually, the net present value (NPV) and the internal rate of return (IRR)

Farm	Capital Cost ($)	NPV ($)	IRR (%)	Benefit: Cost
1	-$1062.90	$1895	156.8%	2.91
2	-$1000.00	-$4410.00	-87.1%	-3.63
3	-$1100.00	$8365	275.3%	9.2
4	-$872.20	$1963	79.0%	3.53

The analysis demonstrates a high IRR for three of the four farms meaning if the participants had the opportunity to invest this money and earn 3.5% returns or invest in temporary fencing to improve lamb survival rates, the fencing option would return higher yields.

The benefit cost analysis shows a range in values, again driven by the number of extra lambs surviving. Removing farm two as an outlier shows that for every $1 invested in the temporary fence (at 8 ewes/ha) yields a minimum return of $2.91 but can be as high as $9.20 (Table 20) depending on the number of extra lambs surviving. With farm two omitted, the average benefit cost was $5.21.

Table 21. The cost-benefit of using temporary fences to achieve greater lamb survival (mob size when ewes stocked at 6/ha) as calculated the initial capital investment discounted at 3.5% annually, the net present value (NPV) and the internal rate of return (IRR)

Farm	Capital Cost ($)	NPV ($)	IRR (%)	Benefit: Cost
1		No data available		
2		No data available		
3	-$1100.00	$1591.00	41.0%	2.7
4	-$872.20	$1709.00	59.8%	3.23

The NPV and IRR demonstrate a sound investment in fencing when mob size was halved at the lower stocking rate (Table 21). The highest benefit achieved was 3.2 and the lowest 2.7, average (2.96). The reason for the lower net benefit in the mob stocked at 6 ewes/ha compared to the mob stocked at 8 ewes/ha was due to the fact that in the first year of the trial, a stocking rate of 6 ewes/ha was not measured and therefore the returns from fencing have only two years of benefits versus three years of benefits for 8 ewes/ha. Secondly, the number of extra lambs surviving is lower at 6 compared to 8 because the mob size was effectively smaller and therefore there were less lambs available to off-set the fence cost, even though on a percentage basis, survival was higher.

4.7.4 The effect of no salvage value and a fence lifespan of 10 years

Typically, capital purchases have a lifespan of longer than three years (length of this research trial) and have a salvage value. The salvage value is how much the piece of equipment is worth at some future point in time. However, individuals will value the same capital purchase in different ways, for example initial purchase cost, condition of the item and/or time since purchase.
The following analysis assumes that the fence has no salvage value after a ten year period and that each farm continues to get the lowest number of extra lambs surviving from the results they achieved in first three years of the trial (Table 22). For example, if the farm had an extra 39 lambs in year one, 83 lambs in year two and 27 lambs in year three, 27 will be the number used in the analysis from year 4 to year 10 to demonstrate a worst case scenario.

Table 22. The total number of extra lambs surviving when mob sizes were stocked at 8 ewes/ha or 6 ewes/ha across the trial period and the values used in the benefit cost analysis from year four to ten

Mob sizes at 8 ewes/ha										
Farm	**YEAR**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	41	41	41	41	41	41	41	41	41	41
2	Not analysed									
3	39	83	27	27	27	27	27	27	27	27
4	12	4	26	4	4	4	4	4	4	4
Mob sizes at 6 ewes/ha										
1	Not analysed									
2										
3	0	4	35	4	4	4	4	4	4	4
4	0	19	19	19	19	19	19	19	19	19

Table 23. The cost-benefit of using temporary fences to achieve greater lamb survival (mob size when ewes stocked at 8/ha) when the salvage value of the fence equals zero after 10 years

Farm	Capital Cost ($)	NPV ($)	IRR (%)	Benefit: Cost
1	-$1062.90	$21,101	250.7%	25.1
3	-$1100.00	$17,647	276.2%	20.0
4	-$872.20	$3,082	78.6%	5.22

Table 24. The cost-benefit of using temporary fences to achieve greater lamb survival (mob size when ewes stocked at 6/ha) when the salvage value of the fence equals zero after 10 years

Farm	Capital Cost ($)	NPV ($)	IRR (%)	Benefit: Cost
3	-$1100.00	$2,629	42.8%	3.96
4	-$872.20	$8,206	78.8%	12.7

The results demonstrate that when the effective life of the fence is increased from three to ten years, the salvage value is zero and a conservative number of extra lambs surviving is applied to the model, the benefits at 8 ewes/ha ranged from 5.22:1 to 25:1 and averaged 17:1 (Table 23) while the benefits at 6 ewes/ha were 3.96:1 for farm three and 12.7:1 for farm four, average 8:1 (Table 24). Increasing the life of the fence and removing the salvage value after ten years improved the average benefit cost at 8 ewes/ha from 5.21 to 16.8 and from 2.96 to 8 at mobs stocked at 6 ewes/ha.

4.7.5 Sensitivity analysis

A sensitivity analysis was conducted in Microsoft Excel® to determine the sensitivity of the NPV to lamb price ($/head) and extra lambs surviving across the trial lifespan. A 'worst case' scenario is analysed and the assumptions of the analysis are shown in Table 25 below.

Table 25. The assumptions used in the sensitivity analysis

Lamb price	$65
extra lambs surviving over trial life	38
total income	$1300
Discount rate	3.5%
fence cost	-$ 1,100.00
Present Value benefits	$2,512.08
NPV	$1,412.08
Present Value costs	$1,062.08
BC	2.36

The sensitivity analysis suggests that the number of extra lambs surviving has a greater effect on the NPV than the cost of an additional lamb surviving as shown in table 26 below. For example, increasing price received by $5/head ($65 Vs $70) increases NPV by $96.62, while increasing the survival of lambs by using the temporary fence and increasing from 20 to 25 (equivalent of 6.7 extra lambs per year to 8.3 extra lambs per year) increased NPV by $314.01.

Table 26. Sensitivity analysis comparing the number of extra lambs surviving to the value of an extra lamb surviving

		Value of an extra lamb surviving ($/head)		
	NPV	**$65**	**$70**	**$75**
No. of extra lambs surviving	**20**	$156.04	$252.66	$349.28
	25	$470.05	$590.82	$711.59
	30	$784.06	$928.99	$1073.91
	35	$1098.07	$1267.15	$1436.23
	40	$1412.08	$1605.31	$1798.55
	45	$1726.09	$1943.48	$2160.87
	50	$2040.10	$2281.64	$2523.19

4.8 Extension and communication activities

A range of extension and communication activities were conducted throughout this trial as summarised below:

- Annual Grasslands Society of Southern Australia field day at Willaura VIC attended by 65 producers
- Presentation at MLA Pasture Update in Stawell VIC attended by 40 producers
- Presentation Nullawil VIC attended by 35 producers
- Presentation Pigeon Ponds VIC attended by 25 producers
- Presentation Dookie VIC attended by 25 producers
- 1 x presentation with members of the Willaura BWBL group 2018 attended by 15 members
- 1 x presentation with members of the Willaura BWBL group 2019 attended by 21 members
- 1 x field day with members of the Willaura BWBL group 2018 attended by 19 members
- 1 x field day with members of the Willaura BWBL group 2019 attended by 12 members
- Presentation to members of the Cavendish BWBL group attended by 12 members
- Presentation to members of the Warracknabeal BWBL group attended by 8 members
- Presentation to the South Australian Livestock Consultants group attended by 16 members
- Discussion of results and presentations to five LTEM groups encompassing 28 producers
- 4 x Producer case studies (Appendix 8.3)
- Various print and radio publicity (Appendix 8.2.1)

5 Discussion

The objective of this trial was to demonstrate a 10% improvement in twin lamb survival when the ewe mob size was halved at and during lambing (keeping the same stocking density) using temporary fencing. We investigated two different stocking densities; 8 ewes/ha and 6 ewes/ha to achieve desired mob sizes with respect to paddock size. The trial did not directly compare the survival of lambs at different stocking densities – for example 8 ewes/ha not split Vs 6 ewes/ha not split but rather what effect reducing the mob size at the same stocking density had on twin lamb survival.

Across all farms, years and stocking rates there was a 4.8% improvement in twin lamb survival, representing a 9.8% improvement in lamb marking rate. The survival rates varied both within and between farms, across seasons and between stocking rates.

For example, the mean survival ranged from 3.6% to 5.2% across the three year trial and ranged from -0.1% to 8.5% between all four farms (3 Merino and 1 composite) and -0.1% to 7.1% from the three Merino farms only. At the lower stocking rate (and hence mob size) of 6 ewes/ha, survival was 8.3% greater in the split mob versus the un-split mob while at 8 ewes/ha the difference between the subdivided paddocks and non-divided paddocks was 2.9%.

The differences in survival observed between split and not-split paddocks was significantly different ($p=0.050$) and ewe condition score was a co-variate that had a significant effect on lamb survival. This result is not surprising given the previous research work that has demonstrated the importance of ewe condition score on lamb survival (Oldham *et al* 2011; Hocking Edwards *et al* 2011; Behrendt *et al* 2011). Similarly, the effect of feed on offer at lambing has been shown to influence survival (Oldham *et al* 2011), however in this trial, there was no significant difference in FOO between years and across properties. An observed difference in FOO across properties and years may have occurred if more properties were enrolled in the trial across different geographical areas. Since the participants in this trial were following the Lifetime Wool Research (LTW) guidelines, pre-lambing FOO targets generally met or exceeded recommended targets. The availability of pasture at lambing and through lactation may have encouraged the ewes to stay close to their lambs rather than seeking additional feed which may have contributed to the results observed. Lockwood *et al* (2018) have suggested that higher mob sizes may not compromise lamb survival when FOO during lambing exceeds 2400kg DM/ha. The level of pasture FOO reported in Lockwood's work was not reached during this trial but certainly warrants further investigation.

The overall improvement in lamb survival cannot be directly attributed to reduced stocking density since the density was the same in both the split paddocks and not split paddocks. One possible explanation for the improvement in survival was that the sheep in the subdivided paddock could only access half the paddock area to roam, for example 15ha Vs 30ha, potentially reducing the ability of the ewe to separate from her lambs. Stevens *et al* (1982) investigated the ability of fine wool Merino ewes to rear twin lambs in 12ha paddocks at a stocking density of 12.5 sheep per hectare and showed mortality rates of 37.4% in twin born lambs compared to 9.6% in single born lambs. This work suggests that Merino ewes have lower maternal instincts compared to other breeds. Alexander *et al* (1983) studied the ability of fine wool Merino, Dorset, Romney and Border Leicester cross Merino ewes to keep their lambs together during the first 1-2 days after birth. The authors showed that 46% of twin bearing Merino ewes became permanently separated from a lamb, mostly on the day after giving birth and in around 54% of these cases there was no obvious reasons such as interference by other sheep or birth difficulties. In contrast, permanent separations were reported in 17% of Dorset ewes, 0% in cross-bred ewes and 8% in Romney ewes. The authors concluded that fine-wool Merino ewes are slow to recognise the size of their litters and inherently poor at maintaining contact with more than one lamb in the neonatal period. Similar studies have been performed with Corriedale ewes and shown more separation of lambs from their dams at higher stocking intensities (Winfield 1970).

Reducing the area available for Merino ewes to lamb in has the potential to limit ewe-lamb separations and could therefore improve the survivability of the lambs.

Another explanation in the improvement in survival when the mob size was halved could be that the number of ewes lambing per day was effectively halved in the sub-divided paddocks, reducing possible interference from other lambing ewes and reducing the incidence of mis-mothering. Lockwood *et* al (2018) observed ewes to only occupy 45% of the lambing paddock regardless of mob size and birth type. Stevens *et al* (1981) observed fine wool Merino ewes lambing in 12ha paddocks and observed 90% of ewes lambed where the flock was grazing or resting when labour commenced and only 2% moved away from the flock to lamb when labour started. Even in groups offered shelter, the use of shelter for lambing closely reflected the preference of the flock for shelter and there was no evidence that ewes sought shelter in which to lamb. The ewes enrolled in this trial were not fine-wool Merinos (eg <16µm) and despite the strong, natural flocking behaviour of Merino sheep it is likely that there would be substantial genetic variation between bloodlines that could explain the results observed in this study. Nonetheless, the results observed here demonstrate that with fewer ewes lambing per day or just fewer ewes on a mob basis, survival is improved.

Farm two experienced 2/3 years where survival was worse in the subdivided paddock compared to the unfenced treatment. The differences observed here were a direct result of management intervention. In year one of the trial, the property had higher than usual ewe mortalities during lambing (>6%) resulting in fewer lambs born but interestingly these deaths were higher in the subdivided paddock. Veterinary diagnosis confirmed metabolic disease as the cause. Similarly, in the third year, farm two reported lower survival in the subdivided paddock compared to the control paddock. This was not observed on any other property enrolled in the trial or over the three year length of the trial despite all sheep being the same breed. The owner of this property was reluctant to enter the paddock to autopsy the dead lambs as he was concerned about causing mismothering but speculated that the majority of dead lambs had not been cleaned after birth indicating the lambs were either born dead or the ewe did not stay at the birth site to bond with her lambs. The implications of high ewe mortality during lambing result in lower than expected lamb survival and thus skew the actual survival. In this study, survival was measured against ewes stocked in the paddock pre-lambing and ewe counts were not performed at marking. Reporting lamb survival against ewes scanned and ewes alive at lamb marking will allow producers to identify reproductive wastage and the stage in which it is occurring. Reporting lamb survival against ewes scanned alone does not provide an accurate reflection on lamb survival since the ewes either died during or before giving birth and does not reflect the ability of the lamb to thrive and survive by accounting for the known effects that influence survival of live-born lambs. Recording ewe mortalities during lambing and identifying cause of death will allow producers to determine if low lamb survival was a result of high lamb mortalities or high ewe mortalities during lambing and is also useful for paddock comparisons.

Nowak (1996) explained that the bonding between a ewe and new-born lamb and consequent survival is improved if the ewe can remain at the birth site for a minimum of 6 hrs and that in Merinos, twin lambs that survive beyond the first week after birth are those that established a rapid bond with their dam in the first 12 hours after birth. Other factors such as low levels of feed on offer (<800kg DM/ha) can reduce foetal birth-weight during late pregnancy (Oldham *et al* 2011) and subsequent survival and can also tempt the ewe into moving away from the birth site in search of food although the feed on offer was not considered limiting in any of the experimental paddocks during the trial.

One plausible explanation for the lower survival on farm two could be due to misadventure. It is possible that lambs got through the temporary fence and became stranded from the ewe. It became evident after year one that the bottom wire of the fence had to be placed above the grass so not to short the wire and this would have allowed lambs to cross over the fence.

The results from this trial are in accordance with the findings from Lockwood *et al* (2019) and have shown that when mob size is lowered, additional lamb survival is observed although this varied across sites and between years. Lockwood *et al* (2019) conducted surveys of 88 producers across Australia and New Zealand and found survival of twin born lambs reduced by 3.5% for every additional 100 ewes in the mob at lambing. These results are in agreement with the data collected by those authors and the overall response from this work demonstrated that for every extra 100 ewes in a mob at lambing, survival reduced by 3.4%.

Lockwood *et al* (2019) found that increasing stocking rate by 1 ewe/ha decreased lamb survival by 0.7% when the stocking rate ranged from 1-17 ewes/ha. Similarly, Robertson *et al* (2012) investigated the survival of lambs in sheltered areas and demonstrated that at a stocking rate of 30 ewes/ha, 24% more lambs died between birth and marking compared to a stocking rate of 16 ewes/ha. With respect to mob size, Allworth *et al* (2017) assessed lamb marking data relative to ewe scanning data on 125 mobs of sheep and reported lamb losses of 29% in twin bearing ewes with a tendency of mob size to influence twin lamb survival. Although not significantly different, the authors reported fewer lamb losses when ewe mob size was 200 or less compared to mobs greater than 200 (29% Vs 33% respectively). Experiments carried out by Lockwood *et al* (2020) showed survival decreased by between 1.9% and 2.5% per additional 100 ewes in the mob at lambing regardless of breed. In both examples, the author demonstrated a linear relationship between mob size and survival.

The current industry guidelines suggest lambing twin bearing ewes in mobs no larger than 200 ewes although no recommendations are made on paddock size. The interaction between mob size, stocking rate and paddock size appears to be complex. For example, for set paddock sizes, producers can either stock these paddocks at a specified density to achieve a desired mob size or can aim to achieve a certain mob size which will change the stocking density dependant on paddock size. The linear relationship of survival and mob size highlight the importance of reducing mob size to a practical level which will vary between farms and years. In this research the use of temporary fences to reduce mob size yielded an economic return. The average net benefit across the trial period was $2.78 per ewe, $20.73 per hectare and $15.06 per lamb. The return on capital with investing in temporary fencing was high but varied with the survival response achieved. Extending the useful life of the fence to ten years with no salvage value yielded a 17.1 response with mob sizes that had a stocking density of 8 ewes/ha and an 8:1 return at mob sizes of stocking densities of 6 ewes/ha. The variation in these returns was due to the fact that at lower mob sizes, the number of lambs available to write the capital purchase off was lower and therefore greater survival responses would be required to achieve a break-even point similar to the mob sizes stocked at 8 ewes/ha.

The results suggest that greater survival needs to be achieved when smaller mobs are used or that smaller paddocks could be used to reduce the overall fencing cost. Nevertheless, there was still an economic benefit to using the fences to reduce mob size and the sensitivity analysis demonstrates that the number of extra lambs surviving has the largest influence on profitability compared with fencing cost or lamb value. Further work is required to assess the economic benefit in non-Merino ewes and flocks that are already achieving high survival rates across differing geographical regions across Australia.

Based on these findings, further research investigating the optimal mob size at different stocking rates or paddock sizes on a larger number of properties appears warranted. Furthermore, investigating the additional benefits of pasture utilisation from a whole systems perspective might demonstrate further financial incentives for the use of temporary fences. As producers begin to adopt the strategy of utilising temporary fences, improved knowledge and greater experience will refine the materials used and the construction method employed. Although there are both production and economic benefits of reducing mob sizes using temporary fences – it is not a silver bullet. Greater responses in lamb survival are likely to be achieved with a combined approach to ewe management and nutrition, in particular, following industry best practice for improving lamb survival.

6 Conclusions/recommendations

This trial investigated the use of temporary fences to halve twin ewe mob size at lambing to improve the survival outcomes of their lambs. The work was conducted on commercial sheep and cropping businesses with limited labour and lambing paddock resources. Whilst the aims of the trial were to demonstrate a 10% improvement in survival, the work demonstrated a 4.8% improvement in twin lamb survival when ewe mob size is halved at lambing. Although there were variations in survival across farms and between years the 'worst case' economic analysis yielded an 8:1 return on capital invested in temporary fencing.

Achieving a 10% improvement in twin lamb survival (20% more lambs marked) was over zealous, particularly for the producers enrolled in this trial who are currently following best practice industry guidelines for sheep management. The work does highlight that substantial improvements in survival can be made in conjunction with following LTW guidelines. At the farm level, producers should carefully consider their lambing plan with respect to mob and paddock sizes and the linear relationship between mob size and survival clearly shows that greater survival outcomes are achieved at lower mob sizes. However, high survival outcomes will not be realised by reducing mob size alone and must be integrated into a lambing plan that accounts for other key variables – such as FOO and shelter.

From an application perspective, measuring survival outcomes by paddock and accounting for variability between paddocks (e.g. shelter, topography, FOO) will help inform producers of deficiencies in their plan and areas for improvement. The use of temporary fences at lambing is not new, however, there have been no studies investigating the economic benefits of their use. The fencing cost itself for the relatively low level of investment overall should not be a barrier to adoption given the demonstrated financial return on the investment. Fencing cost and the dollar value of lambs is not the driving force behind the economic proposition of using temporary fencing – it is the number of extra lambs surviving as a result of reducing mob size and mis-mothering at lambing. Permanent fencing to reduce paddock size should be considered for livestock only businesses but for mixed cropping enterprises, large paddocks represent efficiency from a cropping perspective and thus the use of temporary fences through lambing can alleviate this barrier to adoption.

This trial did not investigate the optimal mob size for twin bearing ewes given the variability in paddocks across farms but the results certainly warrant further investigation in this area. Similarly, no recommendations can be made on the optimal paddock size.

Further work should also investigate the potential advantages in pasture utilisation from a whole farm systems perspective by reducing mob size at lambing or by reducing paddock sizes either temporarily or permanently to accommodate small mob sizes.

Realising ewe reproductive potential and minimising poor lamb survival and/or causes of ewe mortality during lambing has the potential to improve productivity and profitability at both the farm gate and industry level, while simultaneously improving the welfare outcomes of ewes and their lambs.

7 Bibliography

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8 Appendix

8.1 Lamb survival results by Farm

8.1.1 Farm one

Year one

		L-shape mid-south		L-shape Rd	
Hamish's 62Ha	Hayshed 30Ha	West 15 ha	East 15 ha	West 15 ha	East 15 ha
8 ewes/ha Traditional SR = 464 ewes	8 ewes/ha NO FENCE = 240 ewes	8 ewes/ha = 120 ewes	8 ewes/ha = 120 ewes	6 ewes/ha = 90 ewes	6 ewes/ha = 90 ewes
703 lambs	323 lambs	198 lambs	166 lambs	155 lambs	143 lambs
75.6%	**67.3%**	**82.5%**	**69.2%**	**86.1%**	**79.4%**

8.1.2 Farm two

Year one

		100 acres middle		100 acres nth	
Pepper 1 25Ha	100 acres sth 20Ha	West 10 ha	East 10 ha	Nth east 10 ha	nth west 10 ha
8 ewes/ha Traditional SR = 200 ewes	8 ewes/ha NO FENCE = 160 ewes	8 ewes/ha = 80 ewes	8 ewes/ha = 80 ewes	6 ewes/ha = 60 ewes	6 ewes/ha = 60 ewes
268 lambs	193 lambs	103 lambs	80 lambs	65 lambs	86 lambs
67%	**60.3%**	**64.4%**	**50%**	**54.2%**	**71.7%**

Year two

Pepper 1 25Ha	100 acres middle West 10 ha	100 acres middle East 10 ha	100 acres sth 20Ha	100 acres nth Nth east 10 ha	100 acres nth Nth west 10 ha
8 ewes/ha NO FENCE = 200 ewes	8 ewes/ha = 80 ewes	8 ewes/ha = 80 ewes	6 ewes/ha NO FENCE = 120 ewes	6 ewes/ha = 60 ewes	6 ewes/ha = 60 ewes
241 lambs	99 lambs	96 lambs	139 lambs	87 lambs	73 lambs
60.25%	**61.9%**	**60%**	**57.9%**	**72.5%**	**60.8%**

Year three

100 acres sth 20Ha	100 acres middle West 10 ha	100 acres middle East 10 ha
8 ewes/ha NO FENCE = 160 ewes	8 ewes/ha = 80 ewes	8 ewes/ha = 80 ewes
193 lambs	92 lambs	95 lambs
60.3%	**57.5%**	**59.4%**

8.1.3 Farm three

Year one

West house nth	West house sth	West Silos		Stock entry	
		nth	sth	West	East
18Ha	22Ha	13 ha	12 ha	10 ha	10 ha
10 ewes/ha	8 ewes/ha	8 ewes/ha	8 ewes/ha	6 ewes/ha	6 ewes/ha
Traditional SR	NO FENCE				
= 180 ewes	= 176 ewes	= 104 ewes	= 96 ewes	= 60 ewes	= 60 ewes
208 lambs	180 lambs	103 lambs	116 lambs	77 lambs	86 lambs
57.7%	**51.1%**	**49.5%**	**60.4%**	**64.2%**	**71.7%**

Year two

West house nth	West Silos		West house sth	Stock entry	
	Nth	sth		West	East
18Ha	13 ha	12 ha	22Ha	10 ha	10 ha
8 ewes/ha	8 ewes/ha	8 ewes/ha	6 ewes/ha	6 ewes/ha	6 ewes/ha
NO FENCE			NO FENCE		
= 144 ewes	= 104 ewes	= 96 ewes	= 132 ewes	= 60 ewes	= 60 ewes
181 lambs	142 lambs	122 lambs	168 lambs	87 lambs	85 lambs
62.8%	**68.3%**	**63.5%**	**63.6%**	**72.5%**	**70.8%**

Year three

West house nth	Stock entry		West house sth	West Silos	
	Nth	sth		West	East
18Ha	10 ha	10 ha	22Ha	13 ha	12 ha
8 ewes/ha	8 ewes/ha	8 ewes/ha	6 ewes/ha	6 ewes/ha	6 ewes/ha
NO FENCE			NO FENCE		
= 144 ewes	= 80 ewes	= 80 ewes	= 132 ewes	= 78 ewes	= 72 ewes
193 lambs	114 lambs	106 lambs	174 lambs	103 lambs	106 lambs
67.0%	**71.2%**	**66.2%**	**65.9%**	**66%**	**73.6%**

8.1.4 Farm four

Year one

Clarkes 15Ha	Red 15Ha	Willows Ridge 7.5 ha	Willows Dam 7.5 ha	Willows Trough 7.5 ha	Willows Crater 7.5 ha
10 ewes/ha Traditional SR	8 ewes/ha NO FENCE	8 ewes/ha	8 ewes/ha	6 ewes/ha	6 ewes/ha
= 150 ewes	= 120 ewes	= 60 ewes	= 60 ewes	= 45 ewes	= 45 ewes
196 lambs	154 lambs	78 lambs	88 lambs	68 lambs	61 lambs
65.3%	**64.2%**	**65%**	**73.3%**	**75.5%**	**67.8%**

Year two

Clarkes 15Ha	Willows Ridge 7.5 Ha	Willows Dam 7.5 ha	Red 15Ha	Willows Trough 7.5 Ha	Willows Crater 7.5 ha
8 ewes/ha NO FENCE	8 ewes/ha	8 ewes/ha	6 ewes/ha NO FENCE	6 ewes/ha	6 ewes/ha
= 120 ewes	= 60 ewes	= 60 ewes	= 90 ewes	= 45 ewes	= 45 ewes
161 lambs	86 lambs	79 lambs	131 lambs	72 lambs	78 lambs
67.1%	**71.7%**	**65.8%**	**72.8%**	**80%**	**86.7%**

Year three

Clarkes 15Ha	Willows Ridge 7.5 Ha	Willows Dam 7.5 ha	Red 15Ha	Willows Trough 7.5 Ha	Willows Crater 7.5 ha
8.8 ewes/ha NO FENCE	8.8 ewes/ha	8.8 ewes/ha	6 ewes/ha NO FENCE	6 ewes/ha	6 ewes/ha
= 132 ewes	= 66 ewes	= 66 ewes	= 90 ewes	= 45 ewes	= 45 ewes
157 lambs	90 lambs	93 lambs	124 lambs	73 lambs	70 lambs
59.5%	**68.2%**	**70.5%**	**68.9%**	**81.1%**	**77.8%**

8.2 Media Release

MEDIA RELEASE – 11th March 2018

TWIN LAMBING SURVIVAL TRIAL

A trial in south-west Victoria aims to improve twin lamb survival rates for farmers with mixed cropping and sheep businesses.

Preliminary results from the first 12 months of the Willaura Best Wool Best Lamb group's improving twin lamb survival project show lower mob sizes lead to better survival but the cost of temporary fencing to achieve the change could be prohibitive.

The project is part of the MLA Producer Demonstration Site program and is being undertaken on four farms in the Willaura region.

Steve Cotton from Dynamic Ag Consulting, who is managing the project, said farmers around Willaura with mixed cropping and sheep businesses wanted to improve their twin lamb survival rates. About one-third of lambs born don't survive. "The farmers are getting good scanning results but fail to get the numbers through the marking cradle," Dr Cotton said.

The trials are using temporary fences for five weeks during lambing to halve mob sizes and gauge the impact on survival.

The project will continue for the next two years.

Dr Cotton said preliminary analysis of the first 12 months of data shows that when the mob size is halved there is improved survival. However, when the stocking rate becomes low relative to the size of the paddock, the number of lambs weaned per hectare goes down.

"Preliminary data suggests we're better off to maintain a relatively modest stocking rate but halve the mob size to improve survival and then maximise the number of lambs weaned per hectare," Dr Cotton said.

The trials are being conducted on four different paddocks on each farm with variations of higher, same and lower stocking rates and temporary fences to change mob size.

"We know if farmers go lower in mob sizes they get better survival but that's not necessarily practical for large scale commercial livestock and cropping enterprises because of the size of these paddocks," Dr Cotton said.

"We're trying to develop guidelines to optimise the survival of twin-born lambs while considering the costs of putting up temporary fencing.

"In the first year we have seen a response across all farms, although there is variation and we want to verify figures during the second and third years. "It's early days but it's exciting and this project has the potential to improve the number of lambs at marking to improve profit."

The first year findings will be discussed at an upcoming Grassland Society of Southern Australia Pasture Update at Stawell Town Hall on April 12.

8.2.1 Media articles

- http://www.standard.net.au/story/5284729/striving-for-better-survival-for-twin-lambs/

- https://www.sheepcentral.com/ewe-trial-finds-small-mobs-at-moderate-stocking-maximises-lambs-weaned-ha/?utm_medium=email&utm_campaign=Sheep%20Central%20News%20Headlines%20March%2019%202018&utm_content=Sheep%20Central%20News%20Headlines%20March%2019%202018+CID_de59392c478053174aaff8055959d42c&utm_source=eGenerator&utm_term=Ewe%20trial%20finds%20small%20mobs%20at%20moderate%20stocking%20maximises%20lambsha

- https://www.mla.com.au/news-and-events/industry-news/fencing-for-lamb-survival/

- https://www.agtrader.com.au/news/livestock-sheep/fencing-for-lamb-survival

- https://www.sheepcentral.com/paddock-and-ewe-management-means-more-lambs-at-wirrinourt/

- https://researchforagriculture.com.au/category/case-studies/

- https://www.stockandland.com.au/story/6661944/changes-help-lake-bolac-farm-hit-its-peak/

- https://researchforagriculture.com.au/2020/02/27/lake-bolac-sheep-farm-reaches-its-peak-after-adopting-changes/

- Radio interview - https://www.countrynews.com.au/@livestock/2018/03/21/97844/improving-twin-survival

- Media article Weekly Times - https://www.weeklytimesnow.com.au/agribusiness/sheep/industry-and-producer-groups-are-looking-for-answers-to-the-lamb-survival-question/news-story/84427cf0a8813d4901f2c7add446658f

8.3 Producer Case Studies

8.3.1 Case study one

Like most sheep farmers, Sean McDougal wants a better lamb survival rate.
His mixed sheep, beef and cropping enterprise has about 5000 sheep, including 3000 breeding.
About 800 of these are white Suffolk and the rest merino.
Over the past five years the number of breeding sheep has increased from 2000 to 3000, while there are about 600 beef cattle sharing the 135-hectare farm between Tatyoon and Merino in south-west Victoria.
Six generations of the family have farmed the land and Sean has been working on the property since 2011.
It's not uncommon for farmers in the area to complain that their good scanning results aren't backed up by good survival rates, and Sean is no exception.
Through the Best Wool, Best Lamb group at Willaura, Sean heard about Dr Steve Cotton's research at four MLA Producer Demonstration Sites at Willaura and Tatyoon into the impact mob and paddock size has on lamb survival and what temporary fencing may offer in the lambing period.
He was keen to be involved and his farm became one of the four trial sites.
"Around this area we get pretty good scanning results but weren't seeing the results in our survival rates," he said. "We don't have a true reflection of how many lambs we're losing as an industry across Australia but we need to try to improve that."
Over the next three years, Sean hopes to increase his farm's survival percentage from around 65-70 per cent to 80-85 per cent.
In the first year he made some ground, with improvements of 3-8 per cent on different stocking rates and mob sizes, with an overall average improvement of 5 per cent.
This coincides with preliminary analysis of the first 12 months of data from the four sites shows which shows that when the mob size is halved there is improved survival. However, when the stocking rate becomes low relative to the size of the paddock, the number of lambs weaned per hectare goes down, another finding reflected on Sean's property.
Sean trialled a variety of options to see what best suits his farm, including a comparison with traditional stocking rates for lambing paddocks.
Most of the farm's paddocks are 15-30 hectares and temporary electric fences were used to split them in half.
He starts lambing at the end of August and puts the ewes in the smaller paddocks at the start of August.
They spend four weeks before lambing and four weeks after in the smaller mobs. After this period the temporary fences will be removed, the lambs counted and compared and then the mobs will be reunited.
Traditionally the farm has had a stocking rate of 10 ewes per hectare, with 15 hectares dedicated to lambing for a total of 150 ewes. For the first year of the trial they reduced that to eight ewes per hectare over the same land, for a total of 120. They then split that mob in half to 60-60 in the third paddock and also tried a lower stocking rate of six ewes per hectare, also split in half for 45 in each small mob.
Overall, Sean recorded a 5 per cent increase in survival by splitting the mobs and reducing the stocking rate to about eight ewes per hectare.

"The smaller the mob, the greater improvement in survival, up towards 8 per cent," he said. "But we worked out on a per hectare basis the lower stocking rate of six ewes per hectare meant the amount of lambs saved per hectare wasn't as profitable with the extra costs of splitting up and lesser use of the land."

As the trials continue this year, all the twinning ewes will be split into mobs of 50. The stocking rate varies but will be around five to six per hectare. Sean is also aiming to make the mob and paddock sizes slightly smaller for the singles, with a higher stocking rate but again splitting the mob in half.

In the first year the trial was conducted with 300 twins and this year it will be expanded to 700-800.

Date: 27 July, 2018
Recorder: Steve Cotton
Outcome/s: Improved lamb survival
Actors: Sean McDougall is a sheep and beef producer near Tatyoon in south-west Victoria, with about 5000 sheep and 650 cattle.
Event: Sean attended a Best Wool, Best Lamb meeting where he learned about the MLA Producer Demonstration sites and volunteered to become part of the program.
Reaction: Like many farmers, Sean wants to improve his lamb survival rate and was keen to be part of a trial that could help the industry across Australia.
Action: As part of the trial, Sean trialled four different stocking rates, mob and paddock sizes to gauge the most suitable arrangement for his farm.
Impact: The first year of trials indicate improvements of 3-8 per cent, with an overall improvement of five per cent.

8.3.1 Case study two

As a fourth-generation farmer, Johnny Gardner has taken over a property steeped in tradition. South Mokanger, between Cavendish and Dunkeld in south-west Victoria, covers 720 hectares near the foothills of the picturesque Grampians National Park.

Johnny has been working on the farm for three years and managing it for the past year. He runs a 10,000-strong composite flock, being predominantly a prime lamb operation with a strong focus on pastures and some cropping.

The family farm was traditionally based on merinos but about seven years ago made the shift to a prime lamb operation.

"In our wetter climate, my father got sick of animals wearing down with bad feet and being fly blown and wool had been a battle for 25-30 years," he said.

Big paddocks have been a long-held practice of the farm, but Johnny has started to adjust to a new way of thinking.

A member of the Best Wool, Best Lamb group and the Grassland Society of Southern Australia, Johnny attended a Grassland Society-MLA Pasture Update at Willaura to hear preliminary results of Dr Steve Cotton's research at four MLA Producer Demonstration Sites at Willaura and Tatyoon into the impact mob and paddock size has on lamb survival and what temporary fencing may offer in the lambing period.

Preliminary analysis of the first 12 months of data from the four sites shows that when the mob size is halved there is improved survival. However, when the stocking rate becomes low relative to the size of the paddock, the number of lambs weaned per hectare goes down.

However, Johnny's goal in finding out more about smaller paddocks was based on pasture utilisation, not lambing rates at this stage.

"Our strategy at the moment is to lock everything up early in containment. We've got plenty of grass and lots of lambs on the ground.

"Steve's results reiterated what is becoming industry practice. It was good to get that confirmation to reassure what we're doing is correct."

Being a generational farm, South Mokanger has bigger paddocks and Johnny is trying to reduce them in line with emerging industry practices.

After hearing Dr Cotton's preliminary results, he organised three seven-day trials aimed at improving pasture utilisation on specific, smaller paddocks.

"Improving pasture utilisation is a no-brainer," Johnny said. "To utilise more pasture is a cheaper way of producing meat."

The farm had one huge 100-hectare paddock but the majority are 40-60ha. Johnny aims to reduce that to 20ha.

The seven-day trials involved temporary electric wires to create smaller paddocks for fodder crop pasture grazing. Eventually permanent fences will be added.

"We had seven days in each plot," Johnny said. "We tried to space out a paddock to last until we started lambing for our late twin ewe lambs. Because we don't have much growth at the moment, we try to keep the pasture going longer."

Although too early to quantify specific outcomes, Johnny believes the trial was a success. "It worked really well; you can see it on paper but to put it in practice and see it actually work was good."

He aimed to keep 1200 sheep in the paddocks, although one was about 800-900. The sheep were encouraged to eat as much as possibly while keeping enough pasture in the paddock to have a solid base for regrowth.

Although the smaller paddock system hasn't been used for lambing at this stage, that is an option Johnny will explore in the future.

"I'm not too stressed about dividing up paddocks for lambing just yet. We're blessed with redgum country and we're really happy with our survival rate. Our aim is to improve our scanning percentages.

"Once we get our paddocks down to 20 hectares we'll try more fine-tuning to take that next step with some fencing to try to get an extra 2-3 per cent lambing.

"We always try to work out the best bang for buck and where you spend your time. We're a prime lamb operation so as many lambs on ground as possible is our strategy."

Date: 26 July, 2018

Recorder: Steve Cotton

Outcome/s: Improved pasture utilisation

Actors: Johnny Gardner is a fourth-generation prime lamb farmer near Cavendish in south-west Victoria with a flock of about 10,000 on 720 hectares.

Event: Johnny attended a Grassland Society-MLA pasture update on the impact mob and paddock size has on lamb survival and what temporary fencing may offer in the lambing period.

Reaction: Johnny was interested in the information not only for potential to improve lambing rates but to improve pasture utilisation.

Action: As a result of the pasture update, Johnny has implemented smaller paddock sizes to improve grazing and pasture utilisation.

Impact: Johnny has seen improved pasture utilisation and less pressure on re-growth since trialling the smaller paddock, short-term rotation system.

Other: Although used primarily for pasture utilisation at this stage, Johnny plans to introduce the smaller paddock sizes for lambing at a later date. His success has been an unexpected positive impact from the demonstration site.

8.3.2 Case study three

The mixed cropping and livestock enterprise Wirrinourt at Lake Bolac has been transformed in recent years, and the results are outstanding.
Smaller mob sizes during lambing, containment paddocks, split lambing, the end of mulesing and changes to pastures have helped the business to improve in almost every aspect.
The farm owned by the Paterson family is on three sites north and south of Lake Bolac, covering about 5100 hectares combined. About 4000 hectares are dedicated to cropping and 1015 to grazing. Each year the farm joins between 8000-9000 ewes, mostly Merinos, reaching a peak of about 20,000 sheep.
Livestock manager Matt Charles says the changes mean the farm is reaching its peak.
"It's like a curve, you get to a certain point and then your gross margin per hectare starts going down; we feel like we're at that point."
One of the key changes has been the introduction of smaller paddocks and mobs during lambing. Matt attended field days at Dr Steve Cotton's four MLA Producer Demonstration Sites at Willaura and Tatyoon, where he saw the ongoing research into the impact mob and paddock size has on lamb survival and what temporary fencing may offer in the lambing period.

Inspired by the success of those trials, the system was implemented at Wirrinourt with immediate results.

"We picked up that mob size and paddock size has a massive influence on survival rates," Matt said.
"In the trials, the results were replicated on all four properties that were lambing at different times and with different sorts of sheep.
"The smaller the paddock and smaller the mob, the higher your survival; and that's exactly what happened to us as well."
In the first year at Wirrinourt, temporary fencing was used to split four paddocks. The next year in addition to temporary options, permanent fencing was added along the front of plantations to create five-hectare paddocks.
The results were better than expected. The first year they marked nearly 20 per cent more lambs than elsewhere on the farm. With nine additional small paddocks the following year, there was again close to 20 per cent more live lambs than other areas.
"I pick the smallest paddocks as the first priority," Matt said. "A lot of our twins won't be in bigger than a 10-hectare paddock and we have a maximum of 10 ewes to a hectare in any of those paddocks."
The farm has put the permanent paddocks in front of plantations and continues to use temporary fencing to split 20-hectare paddocks.
The success of smaller mobs and paddocks is just one of many improvements made in recent years.
"We're getting more intensive; we're probably lambing down about 2000 more ewes now than when I started three years ago," Matt said,
The increase has stemmed from improved pastures, with more annuals to increase carrying capacity, and containment yards used in February to May, allowing more direct feeding and retention of feed for the lambing period.
Inspired by information from the MLA Producer Demonstration Sites and the Best Wool, Best Lamb project, the farm now has 50x100-metre containment pens with attached feeding troughs.

"We put everything in there; all the breeding ewes, weathers, rams," Matt said. "We can feed a bit less by doing that and it stops them baring out the pastures and stops pastures blowing over summer. We can get up to 2000-2500 kg/Dm before we put the sheep in."
About 350 sheep are placed in the pens, but they still have ample room to roam.
"It cuts the job of feeding over summer. They're now in one spot; you can feed 10,000 sheep without opening a gate."
The farm has an average stocking rate of 16.8 DSE per hectare. "That's quite comfortable; if we go much higher, we'd end up feeding more and not getting the benefits," Matt said.
Six years ago, Nick Paterson returned to the farm, starting a gradual succession planning process with his father Rowly. At that time, they were marking about 80 per cent lambs to ewes joined, last year that reached 99 per cent.
Other changes included introducing scanning for singles and multiples and separating accordingly, condition scoring every sheep three or four times a year and a split joining that has been used the past two years.
"Split joining has really helped," Matt said.
"Last year our first cycle of lambing was through some atrocious weather where we had some losses, but the second cycle was perfect weather and pretty much everything survived.
"If we were still on our normal five-week joining, that would have been smack in the middle of the bad weather and the losses would have been a lot worse. This splits the risk."
They now start lambing about August 1 for the first cycle and five weeks later in early September for the second cycle
After joining Dr Cotton on a New Zealand tour, the farm stopped mulesing in 2019.
"I think it doesn't have long left before it is stopped completely but we've had tremendous success from not mulesing in terms of growth rates and survival rates between marking and weaning and then weaning to 150 days old," Matt said.
The changes prompted by the demonstration sites and involvement in the Best Wool, Best Lamb group have created a more efficient and successful farming system,
"We have changed quite a bit but will stick to what we're doing now, but if we find something else, we think can improve, we'll look at that," Matt said.

Date: 12 February 2020
Recorder: Steve Cotton
Outcome/s: Improved lamb survival
Key Player: Matt Charles, livestock manager for Rowly and Nick Paterson's Wirrinourt sheep and grazing enterprise at Lake Bolac.
Event: Matt attended the four MLA Producer Demonstration sites at Tatyoon and Willaura and noted the improved survival rates across all sites from smaller mob sizes and paddocks during lambing.
Reaction: Matt was impressed by the consistency of improved survival rates and wanted to replicate the system and achieve similar outcomes at Wirrinourt.
Action: In the first year, temporary fencing was used to split four paddocks. The next year permanent fencing along the front of plantations was added to create five-hectare paddocks.

Impact: The results were exceptional. The first year they marked nearly 20 per cent more lambs compared to other parts of the farm, and that higher success rate continued the following on a broader scale with close to 20 per cent more live lambs than other areas.

8.3.3 Case study four

A farm near Stawell has recorded up to 10 per cent improvement in lamb survival after introducing temporary fencing and smaller mob sizes at lambing.

Inspired by information heard at a Best Wool, Best Lamb group coordinated by Dr Steve Cotton, farmer Mathew Hall trialed the smaller paddocks and smaller mob sizes last lambing season.

Its success has prompted the Hall family to continue using the system.

At the Best Wool, Best Lamb seminar, Dr Cotton outlined the interim results of four MLA Producer Demonstration Sites at Willaura and Tatyoon. The sites are researching the impact mob and paddock size has on lamb survival and what temporary fencing may offer in the lambing period.

Although he never saw the trial sites, Mathew said the interim results were enough to encourage him to try it.

Mathew farms with his parents Philip and Trudy on a mixed sheep and cropping property about 20km east of Stawell.

They run about 7000 sheep on 2500 hectares, with about 800 hectares dedicated to cropping, including grazing cereals.

Over the past 10 years they have maintained flock numbers while doubling the cropping area with better quality pasture and improved management.

Improving use of the land and getting better lamb survival have been priorities.

“We’ve been establishing areas of lucerne on the creek flats and better country, and cocksfoot, which has been good in the lighter, gravelly country, and newer phalaris species,” Mathew said.

“On light rising country we use a short cropping rotation to establish good perennial pasture and try not to go back in there for 10-15 years. On the better country we might run a 6-8-year rotation.”

The Halls had worked one-on-one with Dr Cotton and attended one of his Best Wool, Best Lamb group presentations at Willaura.

“We didn’t see the MLA demonstration sites but Steve presented about them at Willaura,” Mathew said.

Wanting to improve twin lamb survival, the Halls used temporary fencing in two areas last lambing season.

“The main aim was to try to increase lamb survival in our twins. Singles weren’t too bad but we were lacking a bit in our twin survival,” Mathew said.

The main trial happened on a 40-hectare paddock with similar ground on both sides of a dam.

“It was the first year after the pasture was established so we had a fair bit of feed on the ground,” Mathew said.

One paddock was split in half with a temporary electric fence while the neighbouring paddock wasn’t touched. The split paddock recorded an 8-10 per cent increase in lamb survival over its neighbour.

“It was reasonably significant,” Mathew said, “The system definitely has advantages in trying to keep the mobs smaller, limiting the disturbance with the twins.”

The paddock was fenced through a dam. “The dam was in a good, central spot in the paddock so we fenced through it so both the smaller mobs had access to the water,” Mathew said.

“We just used a bit of sheep yard mesh and put that into the water and then ran the tape over the top of the dam and split the mobs each side of that. It wasn’t too difficult – it was just a matter having the dam in the right place of the paddock.”

There were less than 100 sheep on each side of the temporary fence, now splitting the paddock into two 20-hectare lots.

For the most recent lambing season, the split merino mob recorded about 75 per cent survival while that fell to about 65 per cent where it wasn't divided.

"For the cost of a bit of fencing, it's definitely worthwhile," Mathew added.

Mathew also split a paddock on his personal small block of land which runs separately but is still part of the main farm.

"I split a paddock in half there as well for my twins but I didn't have figures for a comparison," he said.

The main challenge for expanding the split paddock system is access to water during the lambing period, centred on June.

"We've got to have water if we split paddocks," Mathew said. "We have some piped water and troughs but most of our farm relies on catchment dams."

As part of the trial process, the Halls are improving documentation of stocking rates and particularly lamb survival, the biggest issue they want to address. "We're aiming to record good survival data and keep track of what mobs and ages are doing well or particular paddocks that might be better than others," Mathew said.

Last season's smaller mob size and better survival rate was a good outcome.

"It's definitely a better result for the farm," Mathew said. "You've got more selection pressure with breeding; you've got more numbers to work with and you can sell more excess ewes for breeding stock which is likely to increase in demand, and there is a good meat market for lambs or any excess stock."

The Halls will continue with the smaller mobs but say it's not something they will do in every mob across the farm.

"Where we've got the opportunity on a couple of bigger cropping paddocks where we've sown pasture and want to utilise the good quality feed for lambing, we'll split them in half to get mob size down and make it more manageable for lambing, but it has to be practical."

Date: 17 February, 2020

Recorder: Steve Cotton

Outcome/s: Improved lamb survival

Main player: Mathew Hall is a sheep and cropping farmer near Stawell, with about 7000 sheep.

Event: Mathew attended a Best Wool, Best Lamb meeting where he learned about the MLA Producer Demonstration sites and decided to trial the system on two paddocks.

Reaction: Mathew wanted to improve lamb survival rate, particularly for twins.

Action: As part of the on-farm changes, Mathew divided two paddocks with electric fences to reduce the mob size.

Impact: In its first year, this divided paddock yielded 8-10 per cent improvements in twin lamb survival.