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Economic modelling of yearling ewe lambing enterprises

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Abstract

A lack of information on the cost-effectiveness of joining ewe lambs has contributed to relatively poor adoption of the practice. In this project whole farm systems modelling indicated that joining maternal ewe lambs was profitable in all regions and times of lambing that were examined. The increased profitability from joining Maternal ewe lambs were greater than the benefits from mating Merino ewe lambs and greater for longer growing season environments regardless of ewe breed. Mating ewe lambs is a low priority in the wheat belt region. In all analyses it was more profitable to join ewe lambs at 8 months of age rather than at 7 months of age and for the Maternal ewe lambs it was always more profitable to mate all ewe lambs. This was generally the case Merino ewe lambs as well, however the marginal return was often low when more than 50% of Merino ewe lambs were mated and therefore not mating a proportion of the ewe lambs maybe a practical solution for farmers to reduce costs. The economic optimum liveweight at joining varied from 60 to 80% of their mature weight, and only in the SW Victoria scenario was it profitable to allocate more feed between weaning and joining to the ewe lambs to be mated, and for all scenarios feeding to gain more weight during joining itself was more profitable. Selling the dry Maternal ewe lambs was always more profitable whereas it was generally more profitable to retain dry Merino ewe lambs. This analysis was successful in generating an understanding and the economic response curves to factors influencing the reproductive performance of ewe lambs. The analysis informed the development of a decision support tool for consultants and farmers to help them decide whether mating ewe lambs is a technology that they should be evaluating compared to other production alternatives. The DST also determines the optimal management system if mating Merino or Maternal ewe lambs together with the impacts on profitability of sub-optimal management. The DST will allow farmers to focus their decision making and management on components of their production system that will provide the greatest financial returns.

Executive summary

Increasing the number of ewes mated to lamb as yearlings at 12 to 15 months could be an effective avenue to rapidly build ewe numbers and increase lamb supply. However the reproductive performance of ewe lambs is much lower and more variable than that achieved by adult ewes. A lack of information on the longer term impacts of mating ewe lambs, both on the young ewe and her offspring, plus the financial ramifications of joining ewe lambs has also contributed to relatively poor adoption of the practice. MLA-funded projects (B.LSM.0038 and B.PDS.0903) made significant progress towards development of management guidelines to improve the reproductive performance of ewe lambs and more specifically identified the importance of using teasers, liveweight at joining, growth rate during joining and sire of ewe lamb genetics on fertility and reproductive rate. L.LSM.0001 extended this earlier work and completed a metanalysis of datasets relating to the reproductive performance of yearling ewes from Australia and New Zealand, including the effects of: (i) liveweight profile of yearling ewes on the birth weight, survival and growth of their lambs to weaning; (ii) carryover effects of yearling reproductive performance on their hogget reproductive performance and (iii) growth, wool production and reproductive performance of progeny born to yearling ewes compared to progeny born to adult ewes. The current project, which expanded on a preliminary economic analysis completed by L.LSM.0001 that was inconclusive in determining the optimum management of ewe lambs, focused more closely on: (i) the opportunity of delaying mating of the ewe lambs so that joining occurred at 8 or 9 months of age when the ewe lambs were more mature; and (ii) further investigation of only fattening or mating a proportion of the cohort. The analysis was carried out for Merino and Maternal ewes lambs using three different regional versions of the MIDAS suite of models (Great Southern region in WA, Central Wheatbelt in WA and high rainfall SW Victoria) and two times of lambing (autumn and spring). This range of regions covered short to long growing season and variation in the quantity of crop residues available during the summer/autumn period.

The results from the Merino analysis were similar for the medium and higher rainfall scenarios. Based on the assumptions used, when management was optimised joining Merino ewe lambs increased farm profitability by around $30,000 or $10-15ha in the medium rainfall zone in the Great Southern of WA and about $70,000 or $40/ha in the high rainfall zone in SW Victoria. Mating ewe lambs is most suited to the longer season regions and the profitability of mating ewe lambs in the 9 month growing season region in SW Victoria was two to three fold the value achieved in the 6 month growing season region in the Great Southern of WA ($29 *vs.* $13/ewe lamb joined). Mating ewe lambs was also slightly more profitable in an autumn lambing system than in a spring lambing system due to the extra feed that is available for the ewe lamb to gain weight prior to joining and to finish the progeny from the ewe lambs. The profitability of joining Merino ewe lambs in these regions was highly sensitive to sheep meat price and an increase of $1 per kg carcass weight increased farm profitability due to joining ewe lambs by an additional $20,000. By contrast, joining Merino ewe lambs had no impact on farm profitability in the low rainfall wheatbelt region. Mating ewe lambs in the wheatbelt region is not a priority as the supply of crop stubbles through summer and autumn does not offset the impacts of the short growing season. Furthermore, the smaller flock sizes in this region do not justify the skilling up that would be required to implement the system.

As expected, the genetic potential for reproduction influenced the profitability of joining Merino ewe lambs, and this effect varied from $3 to $6/ewe lamb for a 10% increase in the number of lambs weaned (NLW). In all scenarios it was most profitable to join Merino ewe lambs at 8 months of age rather than 7 months of age, and the penalty of early joining varied from about $10/ewe lamb joined in the low rainfall region to more than $20/ewe lamb joined in the high rainfall region. The increase in NLW associated with the ewe lambs being more sexually mature outweighed the cost associated with later born progeny being more expensive to finish or there being less time for the ewe lamb herself to recover to hogget joining at 19 months of age. In most scenarios it was most profitable to

mate all the Merino ewe lambs retained as replacements, however the marginal return was often low (<$5/extra ewe lamb mated) and therefore not mating a proportion of the ewe lambs maybe a practical solution for farmers to reduce costs. This component of the analysis can be used to develop rules of thumb that can be implemented by farmers to help decide what proportion of the animals to mate. The economic optimum liveweight at joining varied from 60 to 80% of their mature weight, and only in the high rainfall zone of SW Victoria scenario was it profitable to feed more between weaning and joining to the Merino ewe lambs that will be mated than if they were not to be mated. SW Victoria is a longer growing season environment and high quality paddock feed is available post weaning that is above the requirements of the ewe lambs that are not being mated. It was profitable to feed Merino ewe lambs to gain more liveweight during the joining period and for the medium and high rainfall regions the effect was about $4 to $5 per ewe lamb per 100 g/day. Only in the autumn lambing scenario in the Great Southern of WA was it profitable to sell the dry ewe lambs after pregnancy scanning. In this scenario pregnancy scanning is occurring prior to the break of the season so selling the dry ewe lambs allows flock size to be increased which can utilise more of the spring flush. In the spring lambing farm in the Great Southern there is a moderate penalty ($6,000/year) for selling the dry ewes, whereas in the autumn lambing Wheatbelt model and in SW Victoria the impact of selling or retaining the dry ewes was small (less than $2,000 per year). The optimum liveweight at their two year old joining varied for the different scenarios but in most cases farm profitability was relatively insensitive to variations in hogget liveweight over the ranges examined. A target hogget liveweight of about 90% of mature weight would appear reasonably robust and in general it was more profitable to preferentially allocate paddock feed to ewe lambs prior to joining than yearling ewes after weaning.

Mating Maternal ewe lambs was profitable in all regions and times of lambing that were examined, however like Merinos and for the same reasons joining Maternal ewe lambs was not sufficiently profitable to be considered a priority for the low rainfall wheatbelt region. In the other regions examined, the increase in farm profitability from joining Maternal ewe lambs was significant at around $70,000 or $35/ha in the medium rainfall zone in the Great Southern of WA and up to $100,000 or $100/ha in the high rainfall zone in SW Victoria. The longer the growing season is reducing the cost of raising the extra progeny particularly the growing out from weaning to sale as a prime lamb. The benefits in each scenario examined are greater than the benefits from mating Merino ewe lambs. This is related to the higher reproduction achieved by the maternal ewe lambs, the higher value of extra lambs born and the reduction in the cost associated with reduced wool growth. Mating ewe lambs is most suited to the longer season regions and the profitability of mating ewe lambs in the 9 month growing season region in SW Victoria was 70% higher than the value achieved in the 6 month growing season region in the Great Southern of WA ($56 vs. $32/ewe lamb). The profitability of joining Maternal ewe lambs in these regions was highly sensitive to sheep meat price and an increase of $1 per kg carcass weight increased farm profitability due to joining ewe lambs by an additional $25,000 in the medium rainfall region up to $35,000 in the high rainfall region.

As per the Merino analysis, the genetic potential for reproduction influenced the profitability of joining Maternal ewe lambs, and this effect varied from $5 to $7/ewe lamb for a 10% increase in NLW. In all analyses it was more profitable to join at 8 months rather than at 7 months, and the penalty of early joining varied from about $1/ewe lamb joined for autumn lambing in the high rainfall zone to $25/ewe lamb joined in the low rainfall region. The increase in the proportion of lambs that have reached puberty and the subsequent increase in NLW outweighed the reduced recovery period prior to joining at 19 months old and the reduction in the period of green feed for the grow out phase of the progeny. This is opposite to the findings for the Merino genotype and probably reflects that the extra growth potential of the maternal genotype can compensate for the reduce time available for recovery and growing the progeny. For the maternal genotype in the environments evaluated there is no incentive to target a proportion of the ewes at weaning or only select a proportion of the ewes at joining. It was most profitable to mate all the ewe lambs and unlike Merinos there was no indication that reducing

the proportion mated would be a useful tactic to reduce costs. The higher liveweight weights achieved at joining and the asymptotic relationship between liveweight at joining and NLW means that there is little increase in NLW from only mating the heavier ewe lambs. The economic optimum liveweight at joining for all scenarios was between 42 and 45 kg or 72 and 75% of mature weight. Extra liveweight gain especially above 75% reduced profitability as this must be achieved by supplementary feeding and results in minimal if any increase in NLW. Only in the SW Victoria spring lambing scenario was it profitable to feed more between weaning and joining to the ewe lambs that will be mated than if they were not to be mated. In all the autumn lambing scenarios the lambs are weaned onto the spring flush and all lambs achieved weights above 40-kg regardless of whether the ewe lambs are being mated. Furthermore, mating is occurring in early summer before weight loss has occurred and therefore achieving higher liveweight at joining can only be achieved by feeding grain to increase liveweight gain in late spring and early summer. This requires high rates of supplementary feeding and it reduces profitability. It was profitable to feed Maternal ewe lambs to gain more liveweight during the joining period and for the medium and high rainfall regions the effect was about $2 to $5 per ewe lamb per 100 g/day. In all scenarios it was profitable to sell the dry ewe lambs. This finding contrast with the merino scenarios and the main difference is the value of the wool produced by the dry animals. The maternal genotype has much less valuable wool and therefore selling the dry ewe lambs as a premium priced prime lamb in the out of season market increases profitability by between $14 and $24/ewe lamb sold. A target hogget liveweight of 95 to 100% of mature weight would appear reasonably robust.

The MIDAS analysis informed the development of a decision support tool for consultants and farmers who are currently not mating ewe lambs to help them decide whether mating ewe lambs is a technology that they should be evaluating. The tool '*Fitting mating ewe lambs into the production priorities'*, synthesises information from a range of sources to estimate whether mating ewe lambs is a priority on the target farm or whether there are other production issues that are likely to have a higher pay-off. The production alternatives that were examined included: (i) Mating ewe lambs; (ii) Improving reproduction from mature ewes by achieving targets for conception or survival of single, twin and or triplet lambs; (iii) Improving reproduction from 2 year old ewes; or (iv) Improving pasture production and utilisation. To assess the potential importance of mating ewe lambs to farm profitability, the user of the DST has the capacity to vary: (i) Breed of sheep; (ii) Length of growing season; (iii) Time of lambing; (iv) ASBV for NLW of the ewe lambs; (v) Age of the ewe lamb at mating; (vi) Age when surplus young ewes are sold; (vii) Liveweight at joining as a proportion of the SRW of the breed; (viii) Liveweight change during the ewe lamb joining period; (ix) Proportion of ewe lambs mated; (x) Management of the dry ewe lambs; and (xii) Price expected for lamb.

The DST also determines the optimal management of the flock if already mating Merino or Maternal ewe lambs together with the impact on profitability of sub-optimal management. The components of management reported includes: (i) Age of the ewe lambs at joining; (ii) Liveweight at joining as a proportion of SRW; (iii) The expected number of lambs weaned (%); (iv) The proportion of the ewes to mate; (v) The target rate of liveweight gain during joining; (vi) Selling or retaining lambs scanned dry; (vii) The amount of extra supplement required (kg/DSE); and (viii) The change in the number of mature ewes (%). The DST essentially develops the relative importance of different critical control points for ewe lamb reproductive performance. Overall, the DST will allow farmers and farm management consultants that have knowledge of the ease and cost that farmers can alter management to focus their decision making and management on components of their production system that will provide greatest financial returns.

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1 Background

The industry-level analysis that underpinned the National Sheep Reproduction RD&E strategy indicated that the second most important area for future research was improving the reproductive performance from yearling ewes mated at 7 to 9 months of age. MLA-funded projects (B.LSM.0038 and B.PDS.0903) made significant progress towards development of management guidelines to improve their reproductive performance and more specifically identified the importance of using teasers, live weight at joining, growth rate during joining and sire genetics on fertility and reproductive rate. L.LSM.0001 extended this earlier work and completed a metanalysis of datasets relating to the reproductive performance of yearling ewes from Australia and New Zealand, including the effects of: (i) liveweight profile of yearling ewes on the birth weight, survival and growth of their lambs to weaning; (ii) carryover effects of yearling reproductive performance on their hogget reproductive performance and (iii) growth, wool production and reproductive performance of progeny born to yearling ewes compared to progeny born to adult ewes.

As most producers remain reluctant to mate young ewes for a yearling lambing because of a lack of information on the longer term impacts and the financial ramifications, this project also used the outputs from this metanalysis to inform economic modelling using MIDAS. However, the number of scenarios modelled for Maternal breed production systems was limited and the determination of the management guidelines with respect to liveweights profiles from weaning to joining, during joining, during pregnancy and between weaning and the 2 year old mating to maximise profitability were not clear. Additional analysis of Maternal production systems across environments and for different lambing times, plus mating ewe lambs 1 to 2 months later that the adult flock, is still needed to formulate more robust guidelines that optimise profitability. This analysis will then inform the creation of a decision support tool to inform on-farm decision making regarding joining ewe lambs. This project will also consolidate key messages from this and other projects relating to improving the reproductive performance of ewe lambs, update the MLA Tip and Tool relating to the reproductive performance of ewe lambs, and provide these key messages in a format suitable for incorporation into extension products such as Bred Well Fed Well and Profitable Grazing Systems.

2 Project objectives

By 31st October 2018:

1. Determined the critical control points and developed management guidelines to improve the reproductive performance from yearling ewes.

2. Consolidated key messages from this and other projects relating to improving the reproductive performance of yearling ewes, updated the MLA Tip and Tool relating to reproductive performance of yearling ewes, and provide these key messages in a format suitable for incorporation into MLA extension products.

3. Developed and tested a decision support tool that provides consultants and farmers information on the profitability of mating yearling ewes for their particular situation.

3 Mating Merino ewes to reproduce as yearlings

An economic analysis was carried out as a component of the MLA project L.LSM.0001 "Improving the reproductive performance of ewe lambs – Management guidelines, economic analysis and decision support tools". That analysis was inconclusive in determining the optimum management of ewe lambs. The main findings of the original analysis was that two areas needed more investigation before a decision support tool could be developed for farmers: (i) the opportunity of delaying mating of the ewe lambs so that joining occurred at 7 or 8 months of age when the ewe lambs were more mature; and (ii) further investigation of only fattening or mating a proportion of the cohort. Therefore, this follow-up analysis was carried out to address these questions in a range of environments and time of lambing.

The conclusions in the original modelling was that mating ewe lambs is a secondary profit driver associated with reproduction in the ewe enterprise. The recommendation was that mating ewe lambs was not practiced unless producers are already: (i) Monitoring ewe condition score; (ii) Managing ewes to LTEM guidelines and achieving the targets; (iii) Scanning ewes and differentially managing twin bearing ewes; (iv) The difference in the weaning rate between the 2 year old lambing and the adult lambing is less than 5%; and (v) Managing a genotype in a system that is delivering greater than 100% weaning for adult ewes. This analysis assumes that the above are being achieved. The original analysis also quantified the optimum management for ewe lambs and hoggets if they were not mated. These findings have been carried into this analysis and are not repeated in this report.

The main differences between this analysis and the analysis reported previously were:

1. This analysis concentrated on each region individually which has helped focus on the profit drivers for that region.

2. Included the examination of mating the ewe lambs at both 7 months of age and 8.5 months. Delaying joining of the ewe lambs increases the proportion of the ewe lambs that have reached sexual maturity but the delayed joining and lambing can make managing the yearling's progeny more expensive. The relationships used to predict NLB and NLW from LW at joining have changed due to including age at joining.

3. The ewe lambs were mated to a terminal sire and the progeny sold as a prime lamb. This was based on the previous analysis that concluded that the progeny of the yearlings were all sold as lambs because the adult productivity of the progeny was lower, especially for wool production.

4. This analysis uses slightly higher prices to reflect changes in market conditions since 2016.

5. In the previous analysis of proportion of animals to include an error was uncovered associated with the feed budget implications of reducing the number mated. This has changed the conclusions associated with this area.

3.1 Methodology

The analysis was carried out with the MIDAS suite of models. Three regional versions were used for the merino analysis and two times of lambing were evaluated in one of the models. The 3 regions are:

1. Great Southern WA. A 550 mm rainfall zone with a 6-month growing season, evaluated with both a May and a July lambing. This model was calibrated to represent a top 20% farmer in the ICON Agriculture database and was further adjusted to achieve 100% reproduction from the adult component of the flock. The model was constrained to 40% crop as is typical in the benchmarking database.
2. Central Wheatbelt WA. A 400 mm rainfall zone with a 5-month growing season, evaluated with a May lambing. The wheatbelt model was calibrated to represent a typical 3,200ha property in the central wheatbelt near Cunderdin.
3. South West Victoria. A 600 mm rainfall zone with a 8.5-month growing season, evaluated with an August lambing. This model was calibrated to represent a top 25% farmer in the Farm Monitor Project. The represented is all pasture, with a moderately productive perennial ryegrass sward.

Each region is reported separately, this layout is based on the finding from the first analysis that it was difficult to draw conclusions that held across each region, genotype and time of lambing.

3.1.1 Prices

Standard prices for meat, wool and grain were used in the analysis and sensitivity analysis was carried out on the price of meat and wool to determine the impact of the variation (Table 1).

Table 1: Standard prices used in the analysis and the ranges examined in the sensitivity analysis.

Commodity	Unit	Standard price	Sensitivity Levels
Meat Prices			+/- 25%
Finished lamb	$/kg DW	5.50	
Premium for out of season	$/kg DW	0.50	
CFA Ewe 5.5yo	$/head	95	
4.5yo		80	
Ewe hogget	$/head	115	
Wether hogget	$/head	102	
Wool price			+/- 25%
19µ	$/kg clean fleece	18	
Supplementary feed price			
Lupins	$/t	300	
Barley	$/t	250	

3.1.2 Analysis specific data

The production data that was used in this analysis regarding the productivity of mated ewe lambs was predominantly from the meta-analysis that was carried out in project L.LSM.0001 and this was described in the L.LSM.0001 report. For merinos this was predominantly based on the MEF database.

For this economic analysis the analysis of the MEF was revisited examining the impact of reproductive performance when:

1. Delaying the joining of the ewe lambs and
2. Culling a proportion of the ewe lambs based on liveweight when birth type of the ewe lambs is not known.

3.1.2.1 Impact of delaying joining

The analysis of the MEF data showed that yearling NLB and NLW could be estimated from liveweight of the ewe lambs at joining. This analysis showed that there was no effect of the ewe lambs own birth type and no effect of age at joining. The coefficients generated, when back transformed and presented as a linear equation were:

$NLB = -80 + 3.27\ LW_J$, when calculated at 45-kg joining weight NLB is 67.4

$NLW = -57 + 2.34\ LW_J$, when calculated at 45-kg joining weight NLW is 48.3

In contrast to the above analysis that showed no response to delaying joining, an analysis carried out by Daniel Brown using approximately 100,000 merino ewe lambs in the Sheep Genetic database showed a linear relationship and that that NLB increased by 1.1% per day and NLW increased 1.4% per day that joining was delayed. The magnitude of the changes was consistent with the meta-data analysis of the maternal ewe lambs. The higher slope for NLW than NLB indicates that lamb survival is increasing with older joining. While this may be realistic because the older ewe may have less trouble with dystocia or could be a better mother, the magnitude of the difference when calculated comparing joining at 7 month old compared with 9 month old is highly unlikely. Therefore, for this analysis the figure of 1.1% per day was used to adjust the average NLW values from the MEF analysis and the assumption was made that age at joining doesn't alter lamb survival.

When combining the findings from the two analyses it was assumed that the NLB and NLW coefficients estimated in the MEF data analysis were relevant to an average age at joining. Therefore in the MIDAS analysis the calculation of the NLW achieved with a 7 month joining was based on being 20 days earlier than the MEF average, i.e. a 22% reduction in the intercept value. Likewise the 8 month old joining was based on joining being 20 days later than the MEF average, i.e. a 22% increase in the intercept value.

3.1.2.2 Response in reproduction to culling on liveweight

In the previous economic analysis, it was assumed that increasing LW at joining by culling animals had half the impact of increasing liveweight at joining through feeding. This was based on the expectation that culling the lighter animals will cull a higher proportion of the multiple born lambs and these are the animals with a higher reproductive potential.

To improve the estimate of the effect of culling on NLW the response of number of lambs born and number of lambs weaned to liveweight at joining was compared when birth type (BT) was included or excluded from the statistical model. It is expected that including BT in the analysis is the response

achieved when all animals are fed more and are heavier. Excluding BT is the expected response if the lighter animals are culled without regard to their birth type. As previously mentioned the analysis of the MEF Merino data showed no statistical difference in the response when BT was or was not included in the statistical model. Therefore, for this Merino analysis the response to nutrition and the response to culling was assumed to be the same.

It was assumed that the variation in liveweight at joining will be reduced if a proportion of the ewe lambs are selected at weaning. The assumed response in LW_J to selection at joining with different proportion selected at weaning is outlined in Table 2.

Table 2: Response in LW at joining (kg) due to selection at joining when varying proportions have been selected at weaning.

Proportion retained at joining	Proportion retained at weaning			
	25%	50%	75%	100%
25%	5.9	7.1	8.3	9.5
50%	3.7	4.4	5.1	5.9
75%	2.0	2.4	2.8	3.2
100%	0.0	0.0	0.0	0.0

Additional to this response to selection at joining is the impact of the selection of the heavier ewes at weaning. It was assumed that the heavier animals at weaning could be the result of either genetically heavier animals or animals that were born earlier but are genetically similar. To reflect that some of the animals are genetically heavier the simulation of the selected animals included an increase in SRW. This increase ensured the simulation accounted for these animals remaining heavier through to joining rather than an impact of age which would diminish as the animals got older. The difference in feed budgets between regions leads to some variation in the response of LW_J to the strategy implemented and the results are presented graphically for each region in the section discussing the proportion of ewes mated.

3.1.3 The analysis

The analysis was carried out as a series of sensitivity analyses. The factors examined and the mechanism by which they affect profitability are outlined below:

1. Age at joining: two levels were evaluated: 7 months and 8 months of age.

   Delaying joining has four effects that impact profitability:

   i. Increases the proportion of the ewe lambs that have reached sexual maturity which increases the expected NLW at a given joining LW.
   ii. It increases the time available for the ewe lamb to gain weight prior to joining. If the feed supply is conducive to gaining weight then this is likely to increase NLW and will be additive to the effects of (a) above.
   iii. Reduces the time available for the ewe lambs to recover from lambing and be at a mating condition for mating as a 2 year old.
   iv. Reduces the time on high quality green feed for the progeny of the ewe lambs and this is likely to increase the cost of finishing the yearling progeny.

2. Proportion of ewe lambs targeted for reproduction. The levels evaluated were:
    a. Proportion of ewe lambs selected at weaning to be targeted for joining. 25%, 50%, 75% & 100% based on weaning liveweight.
    b. Proportion of the ewe lambs targeted that are mated. 25%, 50%, 75% & 100% selected at joining based on pre-joining liveweight.

    Altering the proportion of ewe lambs that are targeted for joining and the proportion of these that are joined has 4 effects that impact profitability:

    i. Selecting a proportion of the ewes to be mated based on liveweight increases the potential NLW achieved and selecting the ewes at joining has a greater effect than selecting the ewes at weaning.
    ii. The cost of feeding the ewes could be reduced if the targeted ewes are being fed to achieve a higher joining weight or are being fed more through the joining period. In some regions there may not be any differential feeding between weaning and pre-joining and therefore targeting the heavier weaners will not alter feeding costs at this time. However, there may be extra feeding of the yearlings joined compared with those not joined during the joining period or between joining and scanning. Extra feeding during joining is profitable if the extra lambs weaned outweigh the cost of the supplement. Extra feeding may also occur between joining and scanning for the autumn lambing flocks because for these flocks the not mated ewes can lose liveweight whereas the mated ewes are fed for maintenance. In the spring lambing flocks both groups of ewes are being fed for maintenance or slow weight gain.
    iii. The number of rams required is reduced and hence the cost of rams is reduced. If rams are used at 2.5%, cost $750/head to purchase and are used for 3 seasons then the cost per ewe mated is $6/ewe.
    iv. Not mating reduces the costs incurred in scanning the yearlings. It was assumed that the yearlings were scanned for litter size at a cost of $0.80/head

3. Nutrition profile. 30 nutrition profiles were evaluated being a combination of:
    a. Nutrition from weaning to joining. 5 levels were evaluated with the level depending on the feed supply in the region. The approximate targets were 65, 70, 75, 80 & 85% of SRW achieved by joining at 7 or 8.5 months. This leads to an increase in weaning percentage as outlined previously.
    b. Nutrition during the 35 days of joining. 2 levels of LW gain were compared and again the level was dependant on the region, approximately maintenance and gaining 100 g/hd/d. The extra weight gain during joining increases NLB by 20% and NLW by 13%.
    c. Nutrition from weaning to joining at 19 month old, achieving different proportion of SRW by joining at 19 months old.

    Altering the nutrition profile for the ewes between weaning and joining at 19 months of age can have three impacts on profitability:

    i. Changing the LW at joining will alter the NLB and NLW of the respective age groups.
    ii. Changing the nutrition profile alters the feed requirements of the animals. This will reflect in the optimum stocking rate or quantity of supplementary grain feeding

required. There can be interactions between the nutrition profile selected and the optimum management such as the profitability of retaining dry yearlings or the proportion of ewes to target at weaning and the proportion to mate.

iii. The death rate of the ewes may vary if the ewes are at a low condition score during lambing.

4. Management of drys. The two options examined were retaining dry ewe lambs or selling dry ewe lambs at scanning as a prime lamb.
   a. The opportunity of selling the dry ewe lambs at scanning was examined to determine if this increased the profitability of feeding the ewes to achieve higher liveweights at joining, such that the ewe lambs that were fed extra but that didn't get pregnant could be sold as a high value product. It is expected that selling the ewe lambs at scanning would be out of season and would attract a premium price of an extra $0.50/kg.
   b. Selling the dry ewe lambs increases subsequent reproduction as a response in the current generation. It was assumed that scanning in later years would increase by 2.7% if dry ewe lambs were sold.
   c. Selling the dry ewe lambs at scanning also results in reducing the wool value from these animals compared to retaining them through and getting a full value hogget fleece.
   d. The impact on the feed budget of the farm depends on the time of sale compared with the break of season. If scanning is occurring after the break then the main feed shortage is over and there is no feed benefit from selling the dry animals. If scanning is occurring prior to the break then selling the dry ewe lambs may allow a greater number of reproducing ewes to be carried.
   e. Selling the dry ewe lambs may affect the ability of the flock to be self-replacing or it may require the older ewes to be retained for an extra year. In this analysis this wasn't incurred because it was assumed that the adult flock was achieving 100% weaning rate and therefore there are a large number of surplus young ewes.

5. Genotype. The levels evaluated were: +/- 15% for NLB with a corresponding +/- 10% for NLW. Altering the genotype of the sheep was represented by a vertical adjustment in the relationship between NLW and liveweight at joining. It was assumed that this was the only change in the genotype and that other traits remained the same. This is not a realistic assumption but was used to isolate the value of having a genotype that matures earlier or has other characteristics that increase reproduction when mated before 12 months of age.
   a. The main effect on profitability is the change in the number of progeny for sale
   b. Altering the genotype also impacts the feed requirement of the ewes during pregnancy and lactation as it affects the number of ewes pregnant and lactating. It also impacts the wool production of the ewe lambs due to the effect of pregnancy and lactation on wool growth.

6. Prices. The sensitivity to changing both meat and wool prices were examined. When changes were made the price of all sale sheep were changed by the same percentage or the price of all different quality of wool were change by the same percentage.
   a. Wool: +/- 15%
   b. Meat: +/- 15%

3.2 Results and Discussion

3.2.1 Great Southern spring lambing

Mating the ewe lambs to reproduce as a yearling increased profitability by $23,000/farm ($10/ha) (Table 3). This equates to $12 per yearling joined. This was associated with mating the whole drop of the 1,831 ewe lambs at 34-kg and achieving a weaning percentage of 63%. This produced 1,161 first cross lambs and increased the number of lambs produced on the farm by about 1,000 head (or 1 extra lamb per WG ha). An extra 15 kg/DSE of grain was fed, spread between finishing the progeny of the yearlings and feeding the yearling ewes prior to lambing and during lactation.

Table 3: Profitability and optimum management for the farm without and with mating yearling ewes. Note: The farm including mating ewe lambs has the optimum management as outlined in the text.

		Ewe Lambs Joined	
		Excluded	Included
Whole farm Profit	$/farm	452877	485172
	$/ha	213	228
Crop Area	%	40%	40%
Total Stock Numbers	DSE	14878	15997
	DSE/WG ha[1]	11.6	12.4
Grain Feeding	t	714.4	1018.1
	kg/DSE	48.0	63.6
Pasture production	t/ha	6.9	7.0
Sale age of CFA ewes	years	5.5	5.5
Sale age of wethers	Age	Hoggets	Hoggets
No. of adult ewes	head	5661	5716
No. of hoggets-Not mated		2673	0
Mated	head	0	2651
Number of lambs weaned	head	5627	7213
Weaning rate whole flock	%[2]	99%	86%
	lambs/WG ha	4.38	5.61
Yearling reproduction			
LW joining	kg		32.9
LW lambing	kg	46.1	45.4
Scanning %	%		91.1
Weaning rate	%		61.6

1. WG ha = winter grazed hectare
2. Lambs weaned per ewe mated

The optimum system when joining ewe lambs was mating 100% of the drop at 8 months old, offering the same feed from weaning to joining for the lambs being mated as those not mated, aiming for 150 g/head/day liveweight gain during joining, retaining the dry ewes and aiming for 80% of SRW for mating at 19 months old.

3.2.1.1 Age at joining

If the ewe lambs were mated at 7 months of age rather than 8 months then profit was reduced by $34,300, this is less profitable than not mating. This result demonstrates the importance of delaying mating of the young ewes to increase the proportion that have reached sexual maturity. The optimum

ration pre-joining for the ewe lambs being mated is maintenance and therefore delaying joining is not increasing the number of lambs weaned. The extra costs associated with finishing the later born lambs is much less than the value of increasing the number of lambs weaned.

3.2.1.2 Genotype

Having a genotype that achieves a higher reproduction from the ewe lambs increases profitability by $7,600 for a 10% increase in NLW. This equates to a net value of $42/extra lamb. This is a lower value than has been estimated elsewhere of the value of extra lambs from adult ewes. This reduction reflects the lower weaning weight and growth rates of the yearling progeny and the cost of finishing the lambs that are born later.

3.2.1.3 Selling dry yearlings

Selling the dry ewe lambs as prime lamb reduces profitability by $4,150 or $7.80 per dry ewe sold. At scanning the dry ewe lambs are weighing about 40-kg and would be a saleable product at a premium price. However, retaining the ewe lambs and getting a full value hogget fleece is more valuable than the benefits associated with the extra sale price. Furthermore, because scanning is occurring after the break of the season the main feed shortage has passed and there is little benefit in reducing stocking rate on the farm.

3.2.1.4 Liveweight change during joining

In the spring lambing analysis for the Great Southern farm the two options examined for liveweight change during joining were gaining 50 g/head/d and gaining 150 g/head/d. Gaining the extra weight increased profit by $8,850 or $4.85/yearling joined. At joining the ewe lambs are weighing less than 40-kg and therefore have unfilled potential for liveweight gain, this combined with the timing of joining in late autumn on poor quality dry feed with low substitution of supplement for dry feed means feeding grain is relatively efficient for weight gain. Therefore, the value of the extra weaning percentage expected is greater than the cost of the grain required and flushing the ewes during joining is profitable.

3.2.1.5 Proportion of ewes mated

Mating a greater proportion of the drop increased profitability (Figure 1), however, there was little effect of the proportion of ewe lambs targeted at weaning with profitability mainly determined by overall proportion mated and not differentiated by the proportion targeted. This is as expected because the most profitable system was not feeding the lambs extra prior to joining so there was no saving of feed from targeting only some ewe lambs.

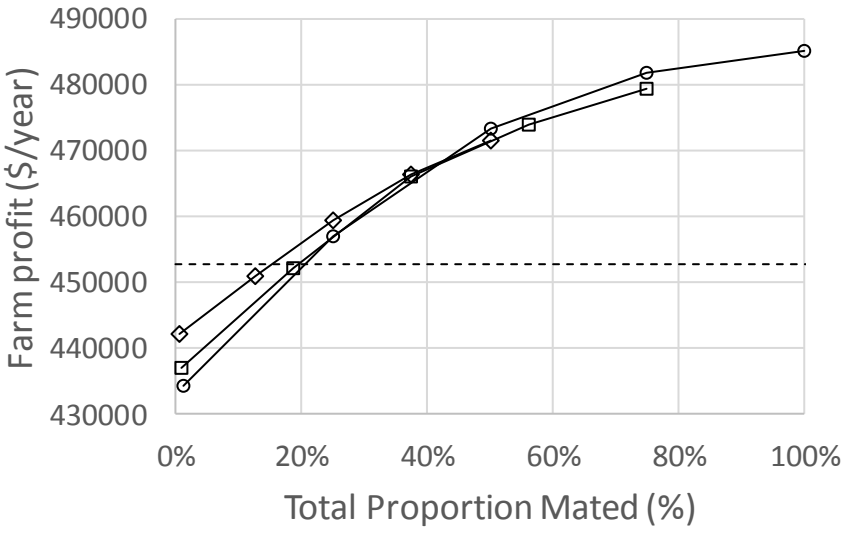

Figure 1: Impact on profitability of varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

The benefit gained from every extra ewe lamb mated diminishes as a higher proportion of the lambs are mated (Figure 2). This is associated with the changes in the average weaning percentage achieved when varying the proportion of ewes mated (Figure 3).

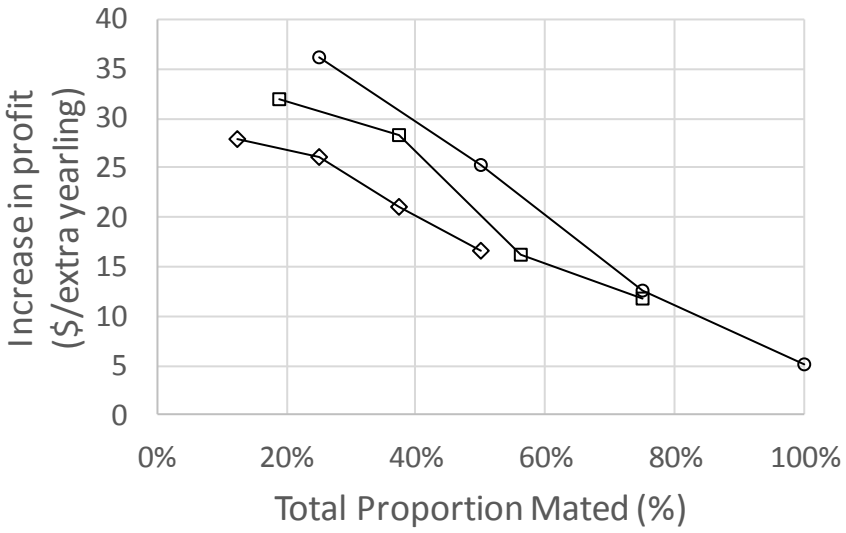

Figure 2: The increase in profit for each extra ewe lamb mated when varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

At any level of ewes mated a higher weaning percentage is achieved if the selection of the ewes is made at joining rather than at weaning (Figure 3). Average weaning percentage was increased from 64% to 86% if only 25% of the ewe lambs were mated compared with all ewes mated (if selected on liveweight at joining).

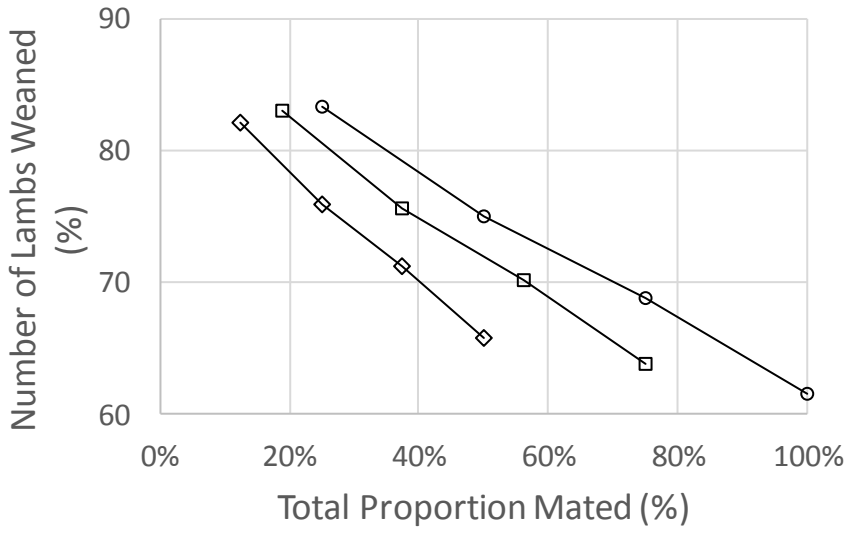

Figure 3: Impact on the average number of lambs weaned from ewe lambs when varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

If the weaning percentage of the extra ewes joined is graphed against the increase in profit per extra ewe joined (Figure 4) this is a representation of the profitability of joining an individual animal with a given expected weaning rate. The breakeven NLW is estimated as 35%. This is the level of reproduction that is required to offset the costs of mating the ewes which in this region includes the cost of rams, the cost of scanning and the cost of flushing the ewes during joining.

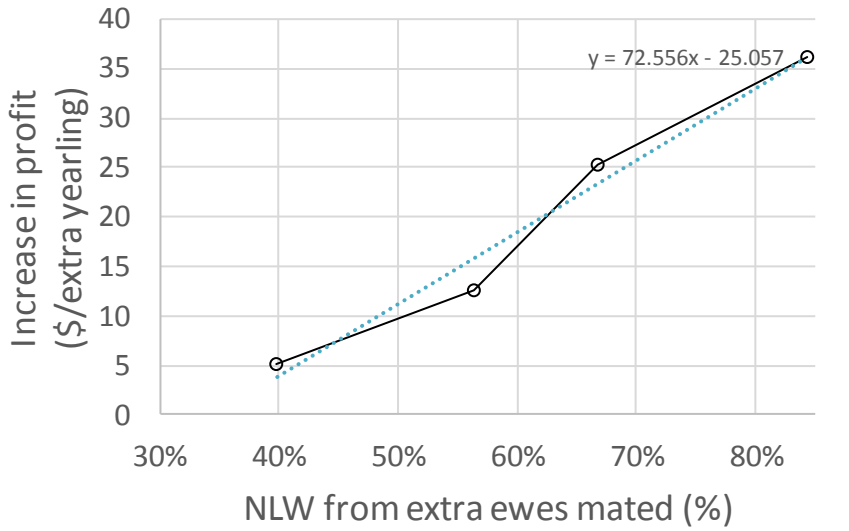

Figure 4: Increase in profit if an extra ewe lamb is joined compared with the weaning percentage expected from that ewe lamb. Based on 100% of ewe lambs targeted at weaning and all selection is based on LW at joining.

3.2.1.6 Nutrition from weaning to yearling joining

Feeding the ewe lambs extra after weaning to achieve a higher weight at joining reduces profit (Figure 5). The reduction in profit is $9/ewe lamb for each extra 10-kg gained and is linear for the majority of the levels evaluated. In the Great Southern region with July/August born lambs that are weaned in

early November the weaners are already the highest priority mob on the farm in the early post weaning period and therefore the extra liveweight can only be achieved through extra supplementary feeding. The supplementary feeding is occurring in early summer when feed quality and availability is higher and therefore the level of substitution of supplement for grain is expected to be higher.

If each kilogram of liveweight gain requires 6-kg of supplement then the cost of gaining 10-kg is $18.00 per head. The extra 10-kg of liveweight at joining is expected to increase NLW by 23% which if the extra lambs are valued at $42/head is worth $9.80. This would equate to a reduction in profit of $8.20/ewe lamb fed.

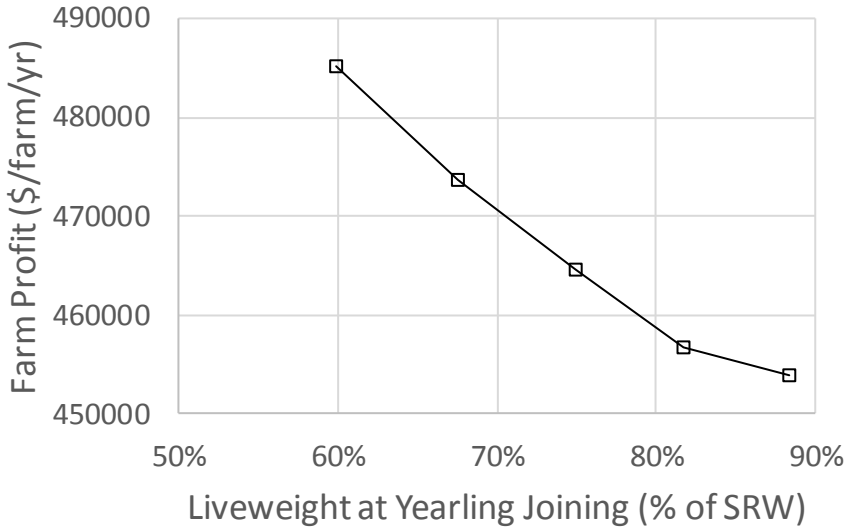

Figure 5: Impact on profit if ewe lambs are fed to achieve different liveweight at joining.

3.2.1.7 Nutrition of the yearling post weaning

Feeding the yearling ewes extra during the recovery period from weaning to their 2 year old joining also reduces profitability (Figure 6), which indicates that feeding grain to increase conception is not profitable. The reduction in profit per unit increase in liveweight is less for the yearlings gaining weight after weaning than it is for ewe lambs gaining weight prior to joining. The older ewes are less responsive in NLW per kg of liveweight at joining than the ewe lambs but the extra lambs from adults are more valuable than extra lambs from yearlings.

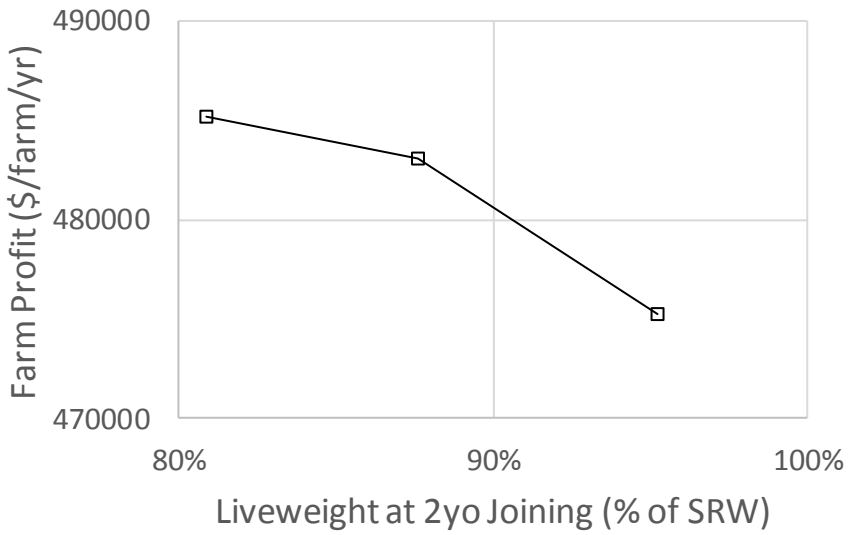

Figure 6: Variation in farm profit and the effect of varying the recovery of the yearling ewes after weaning their lambs.

3.2.1.8 Sensitivity to meat and wool price

Mating ewe lambs is more profitable if meat price increases but is insensitive to the price of wool (Figure 7). If the price of prime lamb is below $4/kg then there is very little benefit from mating ewe lambs, whereas if the price increases to $7/kg then the benefit increases to more than $70,000 per year. At current prices mating ewe lambs would increase profitability by between $40,000 and $50,000 per year.

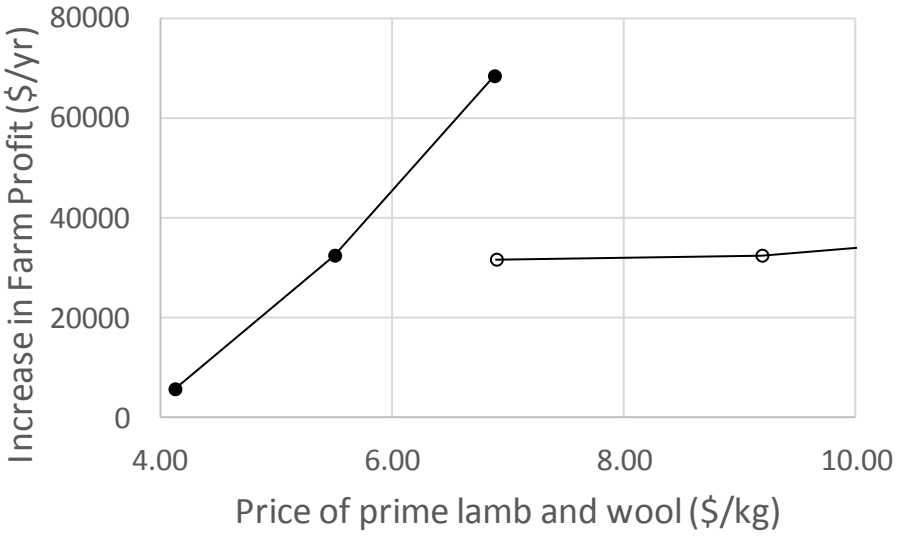

Figure 7: Change in profit from joining ewe lambs if meat price (●) or wool price (○) changes by 25%

3.2.2 Great Southern autumn lambing

Mating the ewe lambs to reproduce as a yearling increased profitability by $28,500/farm ($13/ha) (Table 4). This equates to $14 per yearling joined. This was associated with mating the whole drop of the 2022 ewe lambs at 40-kg and achieving a weaning percentage of 65%. This produced 1,315 first cross lambs and increased the number of lambs produced on the farm by about 1,400 head (or 1.3 extra lamb per WG ha). An extra 20 kg/DSE of grain was fed, spread between finishing the progeny of the yearlings and feeding the yearling ewes prior to lambing and during lactation.

Table 4: Profitability and optimum management for the farm without and with mating yearling ewes. Note: The farm including mating ewe lambs has the optimum management as outlined in the text.

		Ewe Lambs Joined	
		Excluded	Included
Whole farm Profit	$/farm	364179	392732
	$/ha	171	184
Crop Area	%	50%	50%
Total Stock Numbers	DSE	11144	12187
	DSE/WG ha[1]	10.5	11.4
Grain Feeding	t	798.5	1109.5
	kg/DSE	71.7	91.0
Pasture production	t/ha	5.8	5.8
Sale age of CFA ewes	years	5.5	5.5
Sale age of wethers	age	Hoggets	Hoggets
No. of adult ewes	head	4239	4321
No. of hoggets-Not mated		1972	0
Mated	head	0	2022
Number of lambs weaned	head	4151	5569
Weaning rate whole flock	%[2]	98%	88%
	lambs/WG ha	3.90	5.23
Yearling reproduction			
LW joining	kg		40.1
LW lambing	kg		42.4
Scanning %	%		94.4
Weaning rate	%		65.0

1. WG ha = winter grazed hectare
2. Lambs weaned per ewe mated

The optimum system when joining ewe lambs was mating 100% of the drop at 8 months old, offering the same feed from weaning to joining for the lambs being mated as those not mated, aiming for 50 g/head/day liveweight gain during joining, retaining the dry ewes and aiming for 90% of SRW for mating at 19 months old.

3.2.2.1 Age at joining

If the ewe lambs were mated at 7 months of age rather than 8 months then profit was reduced by $29,350, which is about equal profitability to not mating. This demonstrates the importance of delaying mating of the young ewes to increase the proportion that have reached sexual maturity. The earlier time of lambing means that the ewe lambs have 2 or 3 months of green feed after weaning to

gain liveweight and can achieve heavier weights prior to joining. Once the feed dries off the optimum ration is maintenance and therefore delaying joining is not increasing the number of lambs weaned. The earlier joining in this scenario also means that there is more green feed available to finish the progeny from the ewe lambs, reducing the extra costs associated with finishing the later born lambs.

3.2.2.2 Genotype

Having a genotype that achieves a higher reproduction from the ewe lambs increases profitability by $12,500 for a 10% increase in NLW. This equates to a net value of $52/extra lamb. This is a lower value than has been estimated elsewhere of the value of extra lambs from adult ewes, but greater than the value of an extra lamb for a spring lambing flock in the same region. This increase reflects that the lambing of the yearlings is occurring at a more optimal time in this scenario.

3.2.2.3 Selling dry yearlings

Selling the dry ewe lambs as prime lamb increase profitability by $4,850 or $6.15 per dry ewe sold. At scanning the dry ewe lambs are weighing about 40-kg and are a saleable product at a premium price. Scanning is occurring prior to the break of the season so selling the dry ewe lambs allows the flock size to be increased. This increase in stocking rate outweighs the loss in wool cut from the dry animals.

3.2.2.4 Liveweight change during joining

In the autumn lambing analysis for the Great Southern farm the two options examined for liveweight change during joining were maintaining weight and gaining 50 g/head/d. Gaining the extra weight increased profit by $5,750 or $2.10/yearling joined. At joining the ewe lambs are weighing about 40-kg and joining is occurring during early summer when the quality of the dry feed is high. Together these factors make it more expensive to feed grain to gain weight, however, the value of the extra weaning percentage expected is still greater than the cost of the grain required and flushing the ewes during joining is profitable.

3.2.2.5 Proportion of ewes mated

Mating a greater proportion of the drop increased profitability (Figure 8), however, there was little effect of the proportion of ewe lambs targeted at weaning with profitability mainly determined by overall proportion mated and not differentiated by the proportion targeted. This is as expected because the most profitable system was feeding very similar quantities to the mated and non-mated lambs prior to joining, so there was little saving of feed from targeting only some ewe lambs.

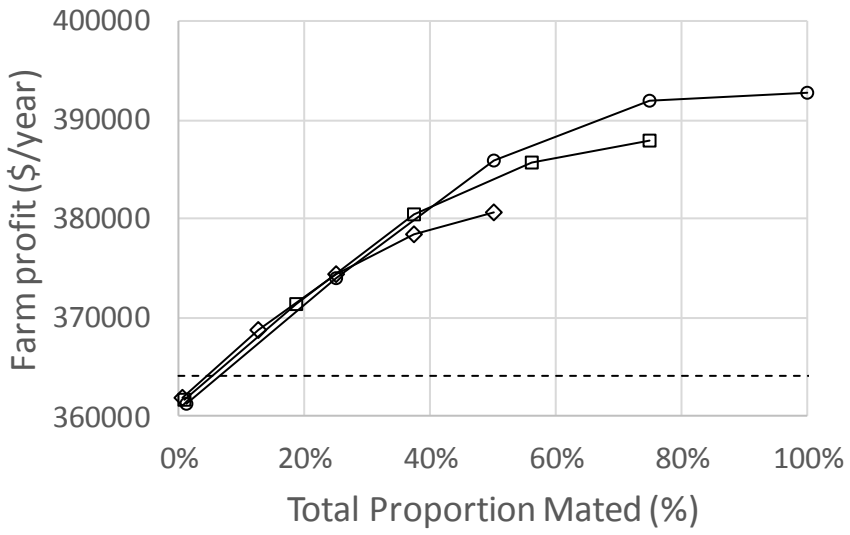

Figure 8: Impact on profitability of varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

The benefit gained from every extra ewe lamb mated diminishes as a higher proportion of the lambs are mated (Figure 9). This is associated with the changes in the average weaning percentage achieved when varying the proportion of ewes mated (Figure 10).

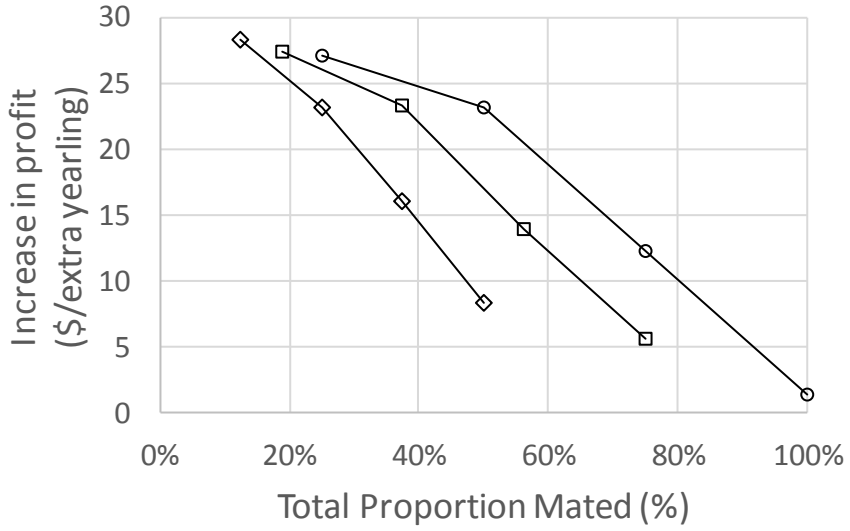

Figure 9: The increase in profit for each extra ewe lamb mated when varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

At any level of ewes mated a higher weaning percentage is achieved if the selection of the ewes is made at joining rather than at weaning (Figure 10). Average weaning percentage was increased from 65% to 76% if only 25% of the ewe lambs were mated compared with all ewes mated (if selected on liveweight at joining).

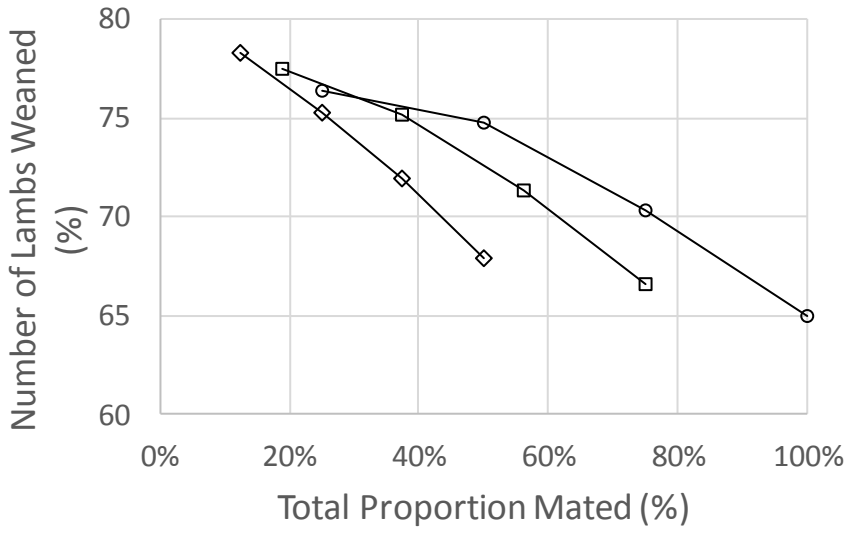

Figure 10: Impact on the average number of lambs weaned from ewe lambs when varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

If the weaning percentage of the extra ewes joined is graphed against the increase in profit per extra ewe joined (Figure 11) this is a representation of the profitability of joining an individual animal with a given expected weaning rate. The breakeven NLW is estimated as 47%. This is the level of reproduction that is required to offset the costs of mating the ewes which in this region includes the cost of rams, the cost of scanning, the cost of flushing the ewes during joining and the cost of the extra feed to maintain the mated ewes in early pregnancy.

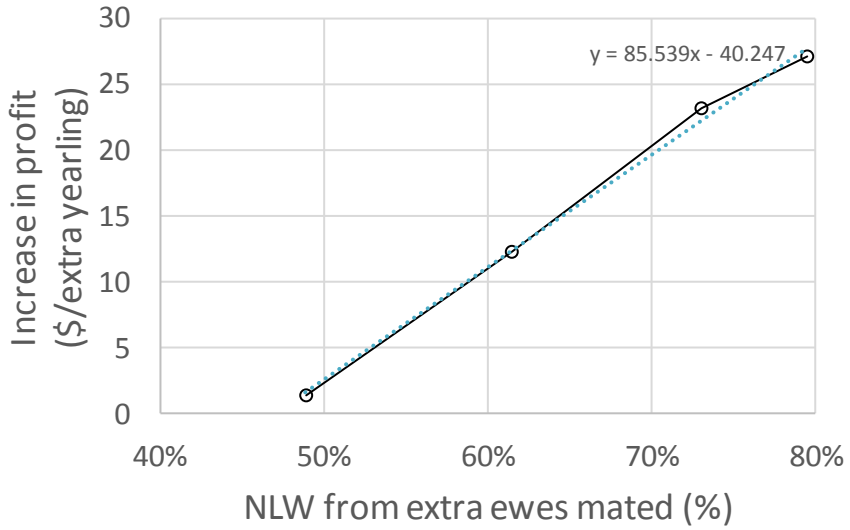

Figure 11: Increase in profit if an extra ewe lamb is joined compared with the weaning percentage expected from that ewe lamb. Based on 100% of ewe lambs targeted at weaning and all selection is based on LW at joining.

3.2.2.6 Nutrition from weaning to yearling joining

Feeding the ewe lambs extra after weaning to achieve a weight at joining greater than 73% of SRW reduces profit (Figure 12). The reduction in profit is $7/ewe lamb for each extra 10-kg gained and is increasing at higher weights. In the Great Southern region with May born lambs that are weaned in

mid-August the weaners have access to high quality feed post weaning. Some extra liveweight can be achieved by reallocation of feed but beyond that level extra liveweight can only be achieved through extra supplementary feeding. The supplementary feeding is occurring in early summer when feed quality and availability is higher and therefore the level of substitution of supplement for grain is expected to be high.

If each kilogram of liveweight gain requires 6-kg of supplement then the cost of gaining 10-kg is $18.00 per head. The extra 10-kg of LW at joining is expected to increase NLW by 23.4% which if the extra lambs are valued at $52/head is worth $12.15. This would equate to a reduction in profit of $5.80/ewe lamb fed.

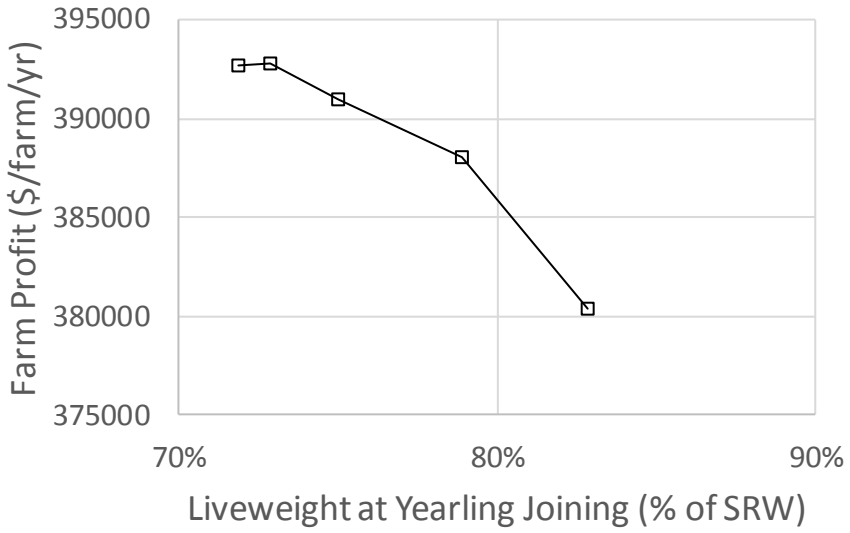

Figure 12: Impact on profit if ewe lambs are fed to achieve different liveweight at joining.

3.2.2.7 Nutrition of the yearling post weaning

Feeding the yearling ewes extra during the recovery period from weaning to their 2 year old joining has very little impact on profitability (Figure 13). The majority of the increase in LW that was examined could be achieved on green feed post weaning. The slight reduction in profit when the ewes are fed to achieve greater than 100% of their SRW indicates that at this level the older ewes are a lower priority than the weaners being fed for their first joining.

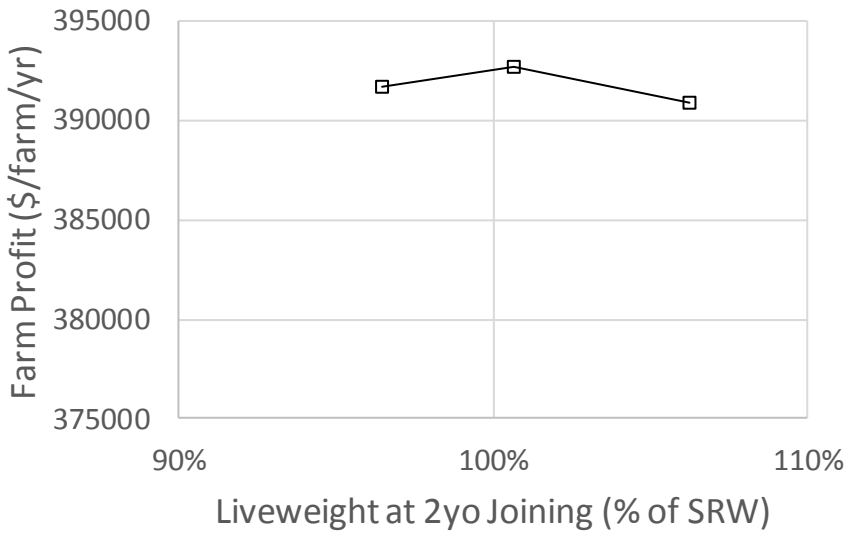

Figure 13: Variation in farm profit and the effect of varying the recovery of the yearling ewes after weaning their lambs.

3.2.2.8 Sensitivity to meat and wool price

Mating ewe lambs is more profitable if meat price increases but is insensitive to the price of wool (Figure 14). If the price of prime lamb is below $4/kg then there is very little benefit from mating ewe lambs, whereas if the price increases to $7/kg then the benefit increases to about $60,000 per year. At current prices mating ewe lambs would increase profitability by about $40,000 per year.

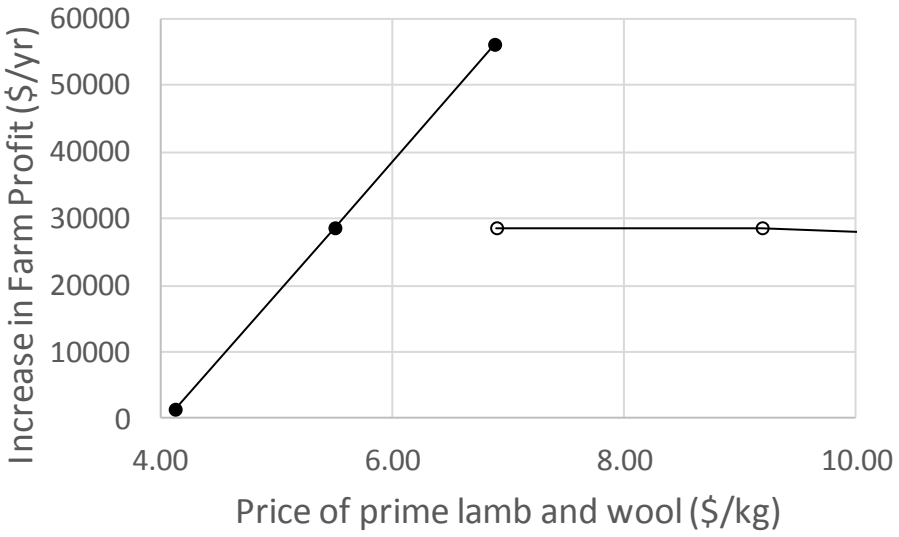

Figure 14: Change in profit from joining ewe lambs if meat price (●) or wool price (○) changes by 25%.

3.2.3 Central wheat belt autumn lambing

Mating the ewe lambs to reproduce as a yearling increased profitability by $1,600/farm ($0.50/ha) (Table 5). This equates to $5.50 per yearling joined. This was associated with mating 75% of the drop of 391 ewe lambs at 40-kg and achieving a weaning percentage of 72%. This produced 211 first cross lambs. The lambs produced per hectare of pasture increased by 0.3 however there was a slight increase in the area of crop and this resulted in a slight reduction in the total number of lambs produced on the farm. Stocking rate was reduced by 0. 5DSE/ha and level of grain feeding remained the same at 30 kg/DSE.

Cropping is the main enterprise on wheatbelt farms in WA and the contribution of mating ewe lambs to total profitability is minor. The different feed supply with extra supply of dry feed during summer and autumn doesn't increase the profitability of mating ewe lambs and doesn't offset the shorter growing season, as seen in the benefit per ewe lamb joined being least in this zone. Therefore, this zone is not a target zone for this technology, furthermore, farmers are unlikely to prioritise upgrading to the level of skill required to implement the system successfully.

Table 5: Profitability and optimum management for the farm without and with mating yearling ewes. Note: The farm including mating ewe lambs has the optimum management as outlined in the text.

		Ewe Lambs Joined	
		Excluded	Included
Whole farm Profit	$/farm	161568	163179
	$/ha	50	51
Crop Area	%	87%	88%
Total Stock Numbers	DSE	2841	2345
	DSE/WG ha[1]	6.8	6.3
Grain Feeding	t	85.3	70.6
	kg/DSE	30.0	30.1
Pasture production	t/ha	2.3	2.2
Sale age of CFA ewes	years	5.5	5.5
Sale age of wethers	age	Hoggets	Hoggets
No. of adult ewes	head	1086	841
No. of hoggets-Not mated		501	98
Mated	head	0	293
Number of lambs weaned	head	1054	1033
Weaning rate whole flock	%[2]	97%	91%
	lambs/WG ha	2.5	2.8
Yearling reproduction			
LW joining	kg	-	40.3
LW lambing	kg	-	42.2
Scanning %	%	-	105.4
Weaning rate	%	-	72.2

1. WG ha = winter grazed hectare
2. Lambs weaned per ewe mated

The optimum system when joining ewe lambs was mating 75% of the drop at 8 months old, offering the same feed from weaning to joining for the lambs being mated as those not mated, aiming for 100 g/head/d liveweight gain during joining, retaining the dry ewes and aiming for 80% of SRW for mating at 19 months old.

3.2.3.1 Age at joining

If the ewe lambs were mated at 7 months of age rather than 8 months then profit was reduced by $2,950, this is less profitable than not mating.

3.2.3.2 Genotype

Having a genotype that achieves a higher reproduction from the ewe lambs increases profitability by $1,650 for a 10% increase in NLW. This equates to a net value of $56/extra lamb. This is a higher value than the other regions and relates to the earlier lambing and the feed available to finish the later born yearling progeny.

3.2.3.3 Selling dry yearlings

Selling the dry yearling ewes as prime lamb reduces profitability by $1,200 or $18.50 per dry ewe sold. The high value per dry ewe is a confusing finding because scanning is occurring before the break of the season and the main feed shortage, therefore selling the drys would allow the flock size to be increased. However, given the small total magnitude of the profit impact this hasn't been followed through.

3.2.3.4 Liveweight change during joining

In this autumn lambing analysis for the Central Wheatbelt farm the two options examined for liveweight change during joining were maintaining liveweight and gaining 100 g/head/day. Gaining the extra weight increased profit by $300 or $1/yearling joined. The benefit per yearling is low indicating that the shorter growing season and high availability of crop residues doesn't reduce the cost of flushing the ewes during joining.

3.2.3.5 Proportion of ewes mated

Profitability is similar when mating between 50% and 75% of the drop (Figure 15). The reduction in the optimum proportion to mate is associated with the lower benefit per ewe joined and therefore a higher weaning percentage is required. This is further reinforcing that the feed supply on a wheatbelt farm is least suited to mating ewe lambs.

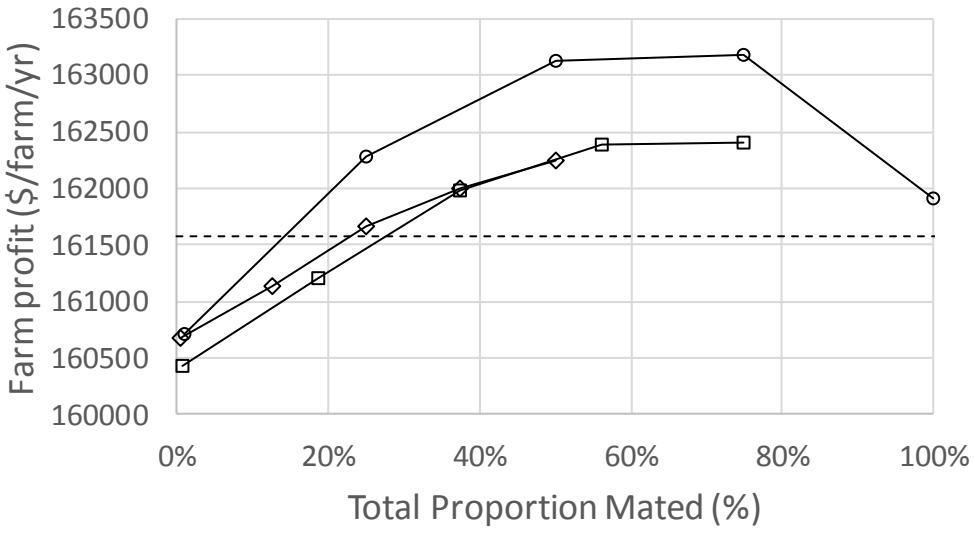

Figure 15: Impact on profitability of varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

The breakeven analysis (Figure 16) indicates that a minimum of 60% NLW is required in the wheatbelt for mating ewe lambs to be profitable. This is the level of reproduction that is required to offset the costs of mating the ewes which in this region includes the cost of rams, the cost of scanning, the cost of flushing the ewes during joining and the cost of maintaining the mated ewes from joining through to scanning.

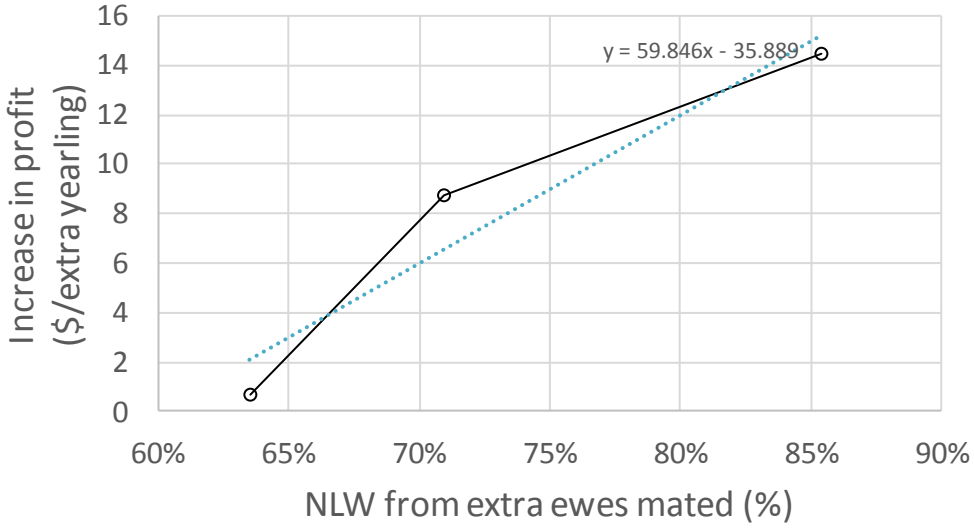

Figure 16: Increase in profit if an extra ewe lamb is joined compared with the weaning percentage expected from that ewe lamb. Based on 100% of ewe lambs targeted at weaning and all selection is based on LW at joining.

3.2.3.6 Nutrition from weaning to yearling joining

Feeding the ewe lambs extra after weaning to achieve a higher weight at joining reduces profit (Figure 17). The reduction in profit is curvilinear indicating that the feeding required to gain the weight varies depending on the level of weight gain specified. On the wheatbelt farm there is some high quality

stubbles available and these can be allocated to the highest priority flocks and this can reduce the level of supplementary grain feeding required.

Figure 17: Impact on profit if ewe lambs are fed to achieve different liveweight at joining.

3.2.3.7 Nutrition of the yearling post weaning

Feeding the yearling ewes extra during the recovery period from weaning to their 2 year old joining also reduces profitability (Figure 18), which indicates that feeding grain to increase conception is not profitable. The reduction in profit per unit increase in liveweight is less for the yearlings gaining weight after weaning than it is for ewe lambs gaining weight prior to joining. The older ewes are less responsive in NLW per kg of LW at joining than the ewe lambs but the extra lambs from adults are more valuable than extra lambs from yearlings.

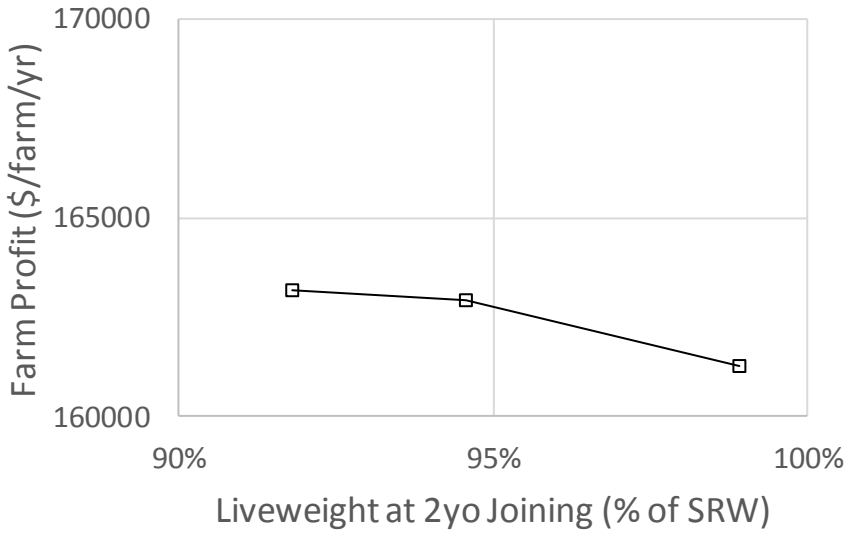

Figure 18: Variation in farm profit and the effect of varying the recovery of the yearling ewes after weaning their lambs.

3.2.3.8 Sensitivity to meat and wool price

In contrast to the other regions the profitability of mating ewe lambs is more sensitive to wool price than meat price (Figure 19). The reduction in the value of mating ewe lambs when wool price increases is associated with the high reproduction flock being less able to adjust to capitalise on the high prices. This is likely associated with the feed budget however because of the minor nature of this finding it has not been followed up.

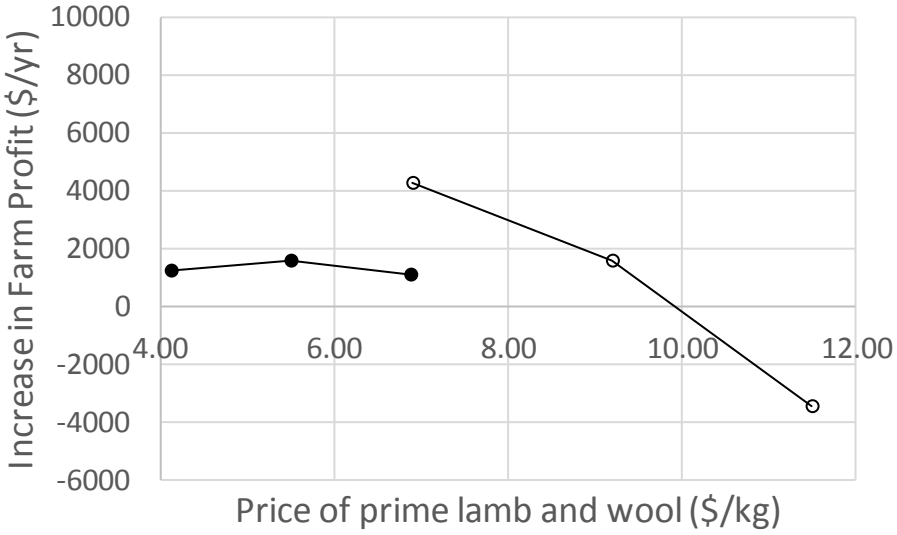

Figure 19: Change in profit from joining ewe lambs if meat price (●) or wool price (○) changes by 25%.

3.2.4 South West Victoria spring lambing

Mating the ewe lambs to reproduce as a yearling increased profitability by $68,800/farm ($69/ha) (Table 6). This equates to $29 per yearling joined. This was associated with mating the whole drop of the 2,375 ewe lambs at 44-kg and achieving a weaning percentage of 87%. This produced 2,071 first cross lambs and increased the number of lambs produced on the farm by about 1,500 head (or 1.5 extra lamb per ha). There was a reduction in grain fed of 0.5 kg/DSE and a reduction in stocking rate of 0.4 DSE/ha.

The optimum system when joining ewe lambs was mating 100% of the drop at 8 months old, increasing the feed supply from weaning to joining for the lambs being mated, aiming for 150 g/head/day liveweight gain during joining, retaining the dry ewes and aiming for 100% of SRW for mating at 19 months old.

Table 6: Profitability and optimum management for the farm without and with mating yearling ewes. Note: The farm including mating ewe lambs has the optimum management as outlined in the text.

		Ewe Lambs Joined	
		Excluded	Included
Whole farm Profit	$/farm	356660	425476
	$/ha	357	425
Total Stock Numbers	DSE	15448	14974
	DSE/ha	15.4	15.0
Grain Feeding	T	333.9	301.2
	kg/DSE	21.6	20.1
Pasture production	t/ha	8.5	8.9
Sale age of CFA ewes	years	5.5	5.5
Sale age of wethers	age	1.4	1.4
No. of adult ewes	head	6366	5606
No. of hoggets-Not mated		1775	0
Mated	head	0	2375
Number of lambs weaned	head	5574	7073
Weaning rate whole flock	%[1]	88%	89%
	lambs/ha	5.6	7.1
Yearling reproduction			
LW joining	kg		43.9
LW lambing	kg		45.5
Scanning %	%		126.9
Weaning rate	%		87.2

1. Lambs weaned per ewe mated

3.2.4.1 Age at joining

If the ewe lambs were mated at 7 months of age rather than 8 months then profit was reduced by $51,400, which is still more profitable than not mating. There is a high payoff from delaying mating of the young ewes to increase the proportion that have reached sexual maturity. The optimum ration pre-joining for the ewe lambs being mated is to be gaining weight and therefore delaying joining is increasing liveweight at joining and further increasing the number of lambs weaned. SW Victoria is a long growing season environment and green feed is available to contribute to finishing the later born lambs.

3.2.4.2 Genotype

Having a genotype that achieves a higher reproduction from the ewe lambs increases profitability by $11,300 for a 10% increase in NLW. This equates to a net value of $47/extra lamb. This is a lower value than has been estimated elsewhere of the value of extra lambs from adult ewes. This reduction reflects the lower weaning weight and growth rates of the yearling progeny and the cost of finishing the lambs that are born later.

3.2.4.3 Selling dry yearlings

Selling the dry yearling ewes as prime lamb reduces profitability by $1,950 or $6.40 per dry ewe sold. At scanning the dry ewes are weighing about 44-kg and would be a saleable product at a premium

price. However, retaining the ewe lambs and getting a full value hogget fleece is more valuable than the benefits associated with the extra sale price. Furthermore, because scanning is occurring after the break of the season the main feed shortage has passed and there is little benefit in reducing stocking rate on the farm.

3.2.4.4 Liveweight change during joining

In the spring lambing analysis for SW Victoria the two options examined for liveweight change during joining were gaining 50 g/head/d and gaining 150 g/head/day. Gaining the extra weight increased profit by $10,150 or $4.30/yearling joined. Joining is occurring after the break of the season and creating a feed wedge through deferring pastures is a cheap method to achieve weight gain. Therefore, the value of the extra weaning percentage expected is greater than the cost of the grain required and flushing the ewes on green feed during joining is profitable.

3.2.4.5 Proportion of ewes mated

Mating a greater proportion of the drop increased profitability (Figure 20), however, there was little effect of the proportion of ewe lambs targeted at weaning with profitability mainly determined by overall proportion mated and not differentiated by the proportion targeted.

In SW Victoria the optimum profile for the mated ewe lambs is gaining 15-kg compared to their non-mated counterparts. Therefore, there could be some benefit from saving this feed by only targeting the heavier animals in the drop. However, the response to feeding achieved from the light animals is the same as the response from the heavier animals and at the LW achieved by joining even the lightest animals are weaning greater than 65%. Therefore, it is still most profitable to target all animals.

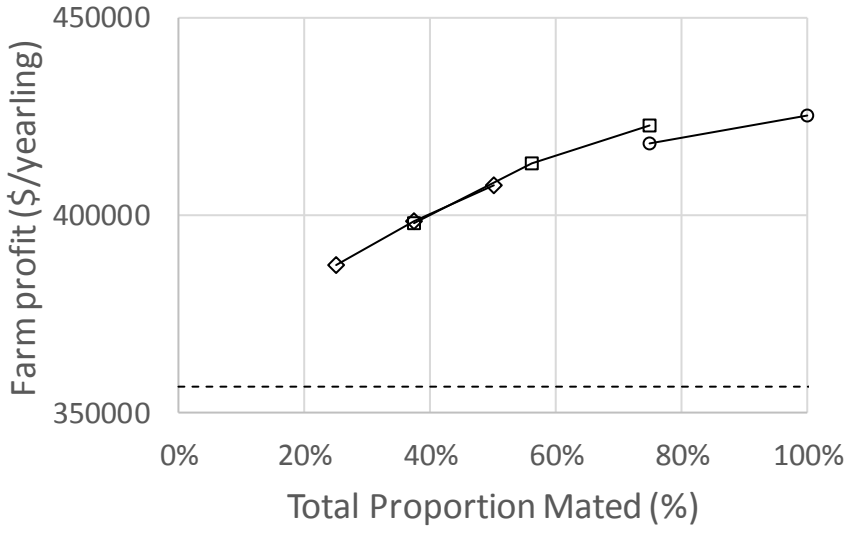

Figure 20: Impact on profitability of varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

The benefit gained from every extra ewe lamb mated diminishes as a higher proportion of the lambs are mated (Figure 21). This is associated with the changes in the average weaning percentage achieved when varying the proportion of ewes mated (Figure 22).

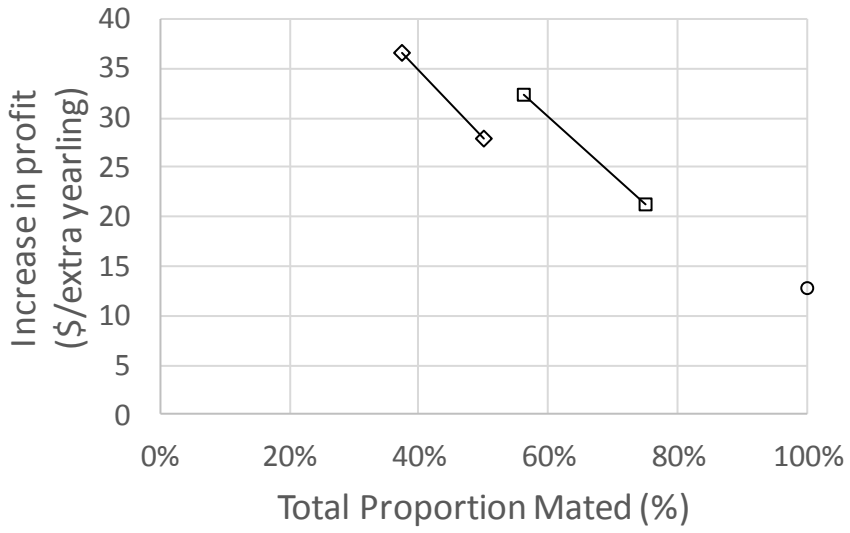

Figure 21: The increase in profit for each extra ewe lamb mated when varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning ◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

At any level of ewes mated a higher weaning percentage is achieved if the selection of the ewes is made at joining rather than at weaning (Figure 22). Average weaning percentage was increased from 87% to 107% if only 25% of the ewe lambs were mated compared with all ewes mated (if selected on LW at joining).

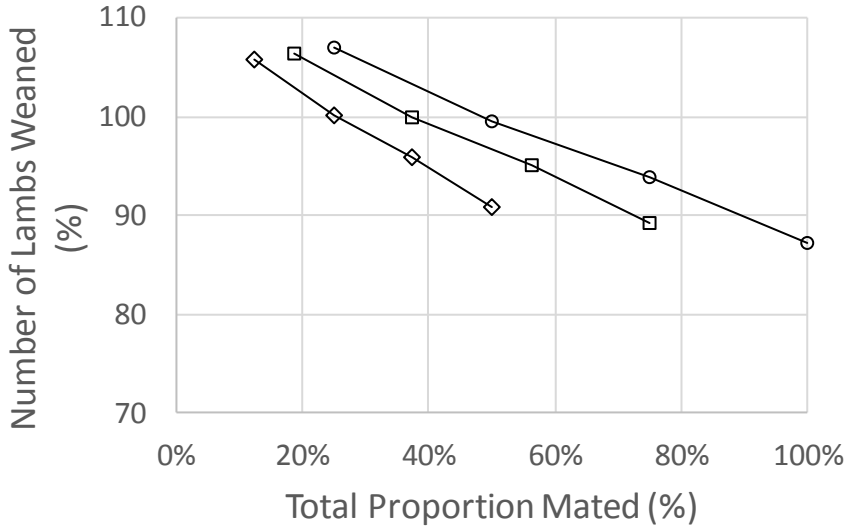

Figure 22: Impact on the average number of lambs weaned from ewe lambs when varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

If the weaning percentage of the extra ewes joined is graphed against the increase in profit per extra ewe joined (Figure 23) this is a representation of the profitability of joining an individual animal with a given expected weaning rate. There is insufficient data points in this regional analysis in order to calculate a breakeven weaning percentage but appears to be similar to the other regions.

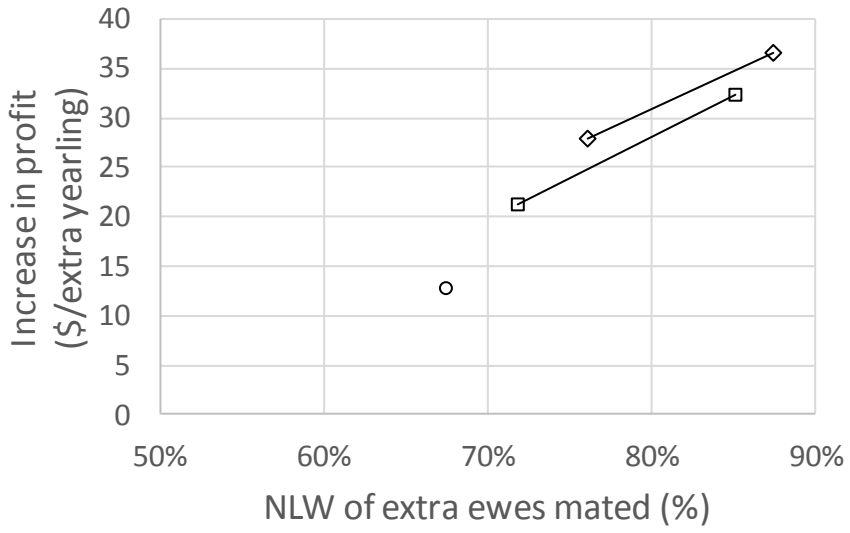

Figure 23: Increase in profit if an extra ewe lamb is joined compared with the weaning percentage expected from that ewe lamb. Based on ◊ 50%, □ 75% and ○ 100% of ewe lambs targeted at weaning and remaining selection is based on LW at joining.

3.2.4.6 Nutrition from weaning to yearling joining

Feeding the ewe lambs extra after weaning to achieve a higher weight at joining increases profit up to 85% of SRW (Figure 24). Below 80% of SRW the increase in profit is $12/ewe lamb for each extra 10-kg gained. In SW Victoria with July/August born lambs that are weaned in early November there is extra high quality green feed that is beyond the requirements of maintaining a dry weaner. Therefore, it is possible to reallocate feed on the farm to the weaners that are to be mated. Beyond this level supplementary feeding will be required and profitability is reduced.

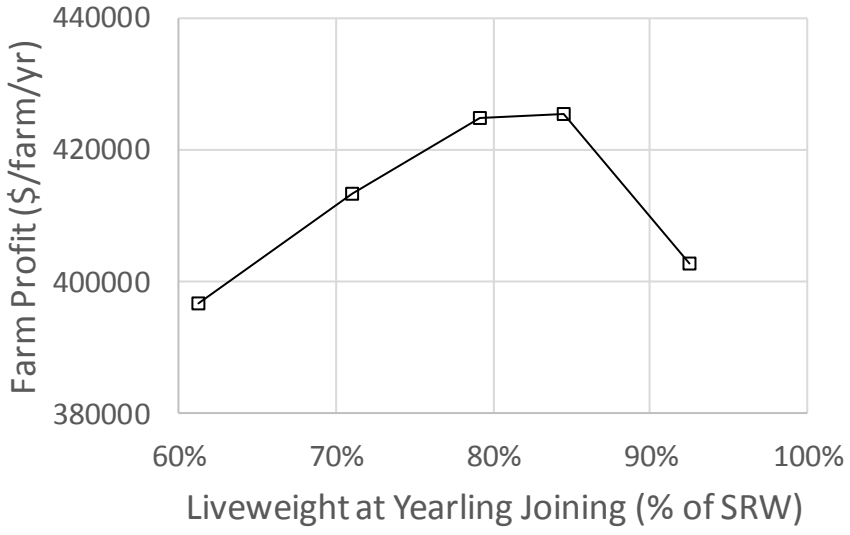

Figure 24: Impact on profit if ewe lambs are fed to achieve different liveweight at joining.

3.2.4.7 Nutrition of the yearling post weaning

Feeding the yearling ewes extra during the recovery period from weaning to their 2 year old joining also increases profitability (Figure 25). This liveweight gain can also be achieved on green feed that is not fully utilised because the feed limiting period is occurring earlier in the autumn/winter period. The increase in profit per unit increase in liveweight is less for the yearlings gaining weight than it is for ewe lambs gaining weight prior to joining indicating that the ewe lambs are a higher priority than the older ewes.

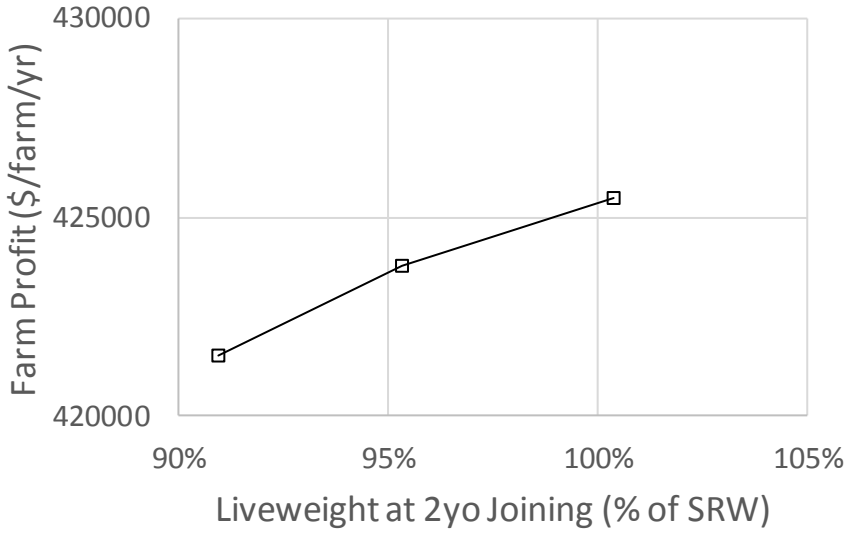

Figure 25: Variation in farm profit and the effect of varying the recovery of the yearling ewes after weaning their lambs.

3.2.4.8 Sensitivity to meat and wool price

Mating ewe lambs is more profitable if meat price increases but is insensitive to the price of wool (Figure 26). Extrapolating the response curve indicates that the price of prime lamb would have to be below $2/kg before it was not profitable to mate ewe lambs. If the price increases to $7/kg then the benefit increases to more than $90,000 per year. At current prices mating ewe lambs would increase profitability by between $70,000 and $80,000 per year.

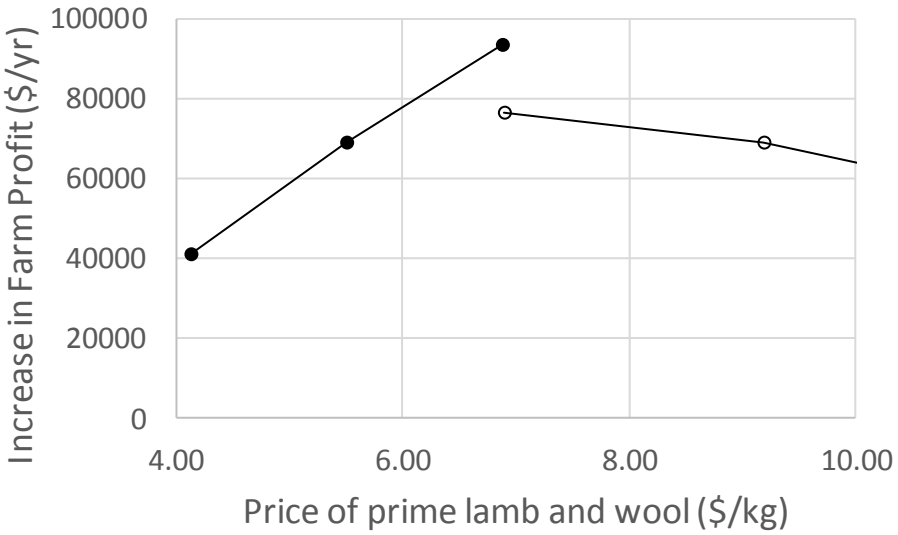

Figure 26: Change in profit from joining ewe lambs if meat price (●) or wool price (○) changes by 25%.

3.2.5 Conclusions

The results from the three higher rainfall scenarios were similar and the wheatbelt scenario was different. Mating ewe lambs in the wheatbelt region is a low priority, the system is not suited to the short growing season and the supply of crop stubbles through summer and autumn doesn't offset this. Furthermore, the small flock sizes in this region do not justify the skilling up that would be required. In the other regions there are also some differences that are associated with differences in the feed supply and this analysis has quantified these differences and related them to the profit drivers outlined in the introduction to this report. Mating ewe lambs is most suited to the longer season regions and the profitability of mating ewe lambs in the 8 month growing season region in SW Victoria was double the value achieved in the 6 month growing season region in the Great Southern of WA. Mating ewe lambs is also slightly more profitable in an autumn lambing system than in a spring lambing system due to the extra feed that is available for the ewe lamb to gain weight prior to joining and to finish the progeny from the ewe lambs. In all scenarios it was most profitable to join at 8 months of age rather than 7 months. The increase in NLW associated with the ewe lambs being more sexually mature outweighed the cost associated with later born progeny being more expensive to finish.

In most scenarios it was most profitable to mate all the ewe lambs, however, the marginal return was often low (<$5/extra ewe lamb mated) and therefore not mating a proportion of the ewe lambs maybe a practical solution for farmers to reduce costs. This component of the analysis can be used to develop rules of thumb that can be implemented by farmers to help decide what proportion of the animals to mate. Only in the SW Victoria scenario was it profitable to allocate more feed between weaning and joining to the ewe lambs to be mated. SW Victoria is a longer growing season environment and high quality paddock feed is available post weaning that is above the requirements for ewe lambs being held over summer as dry sheep.

Only in the autumn lambing scenario in the Great Southern of WA was it profitable to sell the dry ewe lambs. In this scenario scanning is occurring prior to the break of the season so selling the dry ewe lambs allows flock size to be increased which can utilise more of the spring flush. In the spring lambing

farm in the Great Southern there is a moderate penalty ($6,000/year) for selling the dry ewes. In the autumn lambing Wheatbelt model and in SW Victoria the impact of selling or retain the dry ewes is small (less than $2,000 per year).

The main role of this analysis is to provide the background understanding and the response curves that will be used in the decision support tool that can be used by farmers to consider whether to mate ewe lambs. The analysis was successful in achieving this aim and this analysis together with the analysis of maternal flocks will be combined when building the decision support tool.

4 Mating Maternal ewes to reproduce as yearlings

This report follows a similar approach to the merino report but focussing on maternal ewe lambs in a range of environments with different times of lambing.

4.1 Methodology

The analysis was carried out with the MIDAS suite of models. Three regional versions were used for the maternal analysis and two times of lambing were evaluated in one of the models. The three regions are:

1. South West Victoria. A 600 mm rainfall zone with an 8.5-month growing season, evaluated with a May and July lambing. This model was calibrated to represent a top 25% farmer in the Farm Monitor project. The farm represented is all pasture, with a moderately productive perennial ryegrass sward.
2. Great Southern WA. A 550 mm rainfall zone with a 6-month growing season, evaluated with a May lambing. Pasture productivity was calibrated to represent a top 20% farmer in the ICON Agriculture database. The 2,130 ha model farm was constrained to 40% crop as is typical in the benchmarking database. The maternal genotype was calibrated to be similar to the genotype represented in the South West Victoria analysis.
3. Central Wheatbelt WA. A 400 mm rainfall zone with a 5-month growing season, evaluated with a May lambing. The wheatbelt model was calibrated to represent a typical 3,200ha property in the central wheatbelt near Cunderdin with the same genotype as above.

Each region is reported separately, this layout is based on the finding from the first analysis that it was difficult to draw conclusions that held across each region, genotype and time of lambing.

The Maternal enterprise evaluated was a Romney based composite genotype. It was a self-replacing flock with adult ewes mated to composite rams. All wethers and the surplus ewes were sold as finished lambs and cast-for-age ewes were sold at 5.5 or 6.5 years of age, depending on which was more profitable. The genotype is based on productivity data from the top 20% in the Livestock Monitor farms project.

The equations used to represent the maintenance requirement and intake capacity of the maternal genotype was adjusted using the preliminary findings of the project L.LSM.0008 “Lifetime Maternals – Phase II: Feeding standards for Maternal Ewes”. There is further analysis required till this project finalises the equation parameters that best describe the maternal ewes that were measured, so the

adjustments applied in this project are still preliminary. The adjustments applied where a 35% increase in the potential intake capacity and a 15% reduction in the efficiency of use of energy for maintenance and liveweight gain. The values selected are less than the levels that were measured in the animal house and field trials so are conservative however, they do reflect the extra rate of liveweight gain that was measured in Phase 1 of the "Lifetime Maternals" trial.

4.1.1 Prices

Standard prices for meat, wool and grain were used in the analysis and sensitivity analysis was carried out on the price of meat and wool to determine the impact of the variation (Table 7).

Table 7: Standard prices used in the analysis and the ranges examined in the sensitivity analysis.

Commodity	Unit	Standard price	Sensitivity Levels
Meat Prices			+/- 25%
Finished lamb	$/kg DW	5.50	
Premium for out of season	$/kg DW	0.50	
CFA Ewe 5.5yo	$/head	100	
6.5yo		85	
Ewe hogget	$/head	121	
Wool price			+/- 25%
34µ	$/kg clean fleece	6.20	
Supplementary feed price			
Lupins	$/t	300	
Barley	$/t	250	

4.1.2 Analysis specific data

The production data that was used in this analysis regarding the productivity of mated ewe lambs was predominantly from the meta-analysis that was carried out in project L.LSM.0001 and this was described in the L.LSM.0001 report. For Maternals the most suitable data was from Cashmore /Oaklea and Massey University datasets.

For this economic analysis the analysis of the Cashmore dataset was revisited examining the impact of reproductive performance when:

1. Delaying the joining of the ewe lambs and
2. Culling a proportion of the ewe lambs based on liveweight when birth type of the ewe lambs is not known.

4.1.2.1 Impact of delaying joining

The analysis of the Cashmore data showed that yearling number of lambs born (NLB) and number of lambs weaned (NLW) could be estimated from LW of the ewe lambs at joining, the age at joining and the ewe lambs own birth type (Figure 27).

- Equations for NLB & NLW are the same format and are done in multiple steps.
  - Boundary 0/1: $B_1 = c_1 - \sum y_i + (j_1 LW_J) + (j_2 LW_J^2) + (a_1 Age_J) + (a_2 Age_J^2) - \sum b_j$
  - Boundary 1/2: $B_2 = c_2 - \sum y_i + (j_1 LW_J) + (j_2 LW_J^2) + (a_1 Age_J) + (a_2 Age_J^2) - \sum b_j$
  - Boundary 2/3: $B_3 = c_3 - \sum y_i + (j_1 LW_J) + (j_2 LW_J^2) + (a_1 Age_J) + (a_2 Age_J^2) - \sum b_j$
  - then back transformed each of above so $TB_k = e^{B_k}/(1 + e^{B_k})$
  - Proportion dry = TB_1
  - Proportion Single = TB_2 - TB_1
  - Proportion Twin = TB_3 – TB_2
  - Proportion Triplet = 1 – TB_3
  - where
    - LW_J is liveweight at joining (kg)
    - Age_J is age at joining (days)
    - c_i = cut-off coefficient for birth type$_i$ (this joining)
    - j_i = joining coefficient for LW at joining raised to power i
    - a_i = joining coefficient for age at joining raised to power i
    - b_j = coefficient for animals own birth type$_i$
    - Note: NLW has no b_j coefficients

Table 8: Coefficients (source Cashmore analysis, G Kearney 25 May 2018).

	c_1	c_2	c_3	j_1	j_2	a_1	a_2
NLB	33.02	34.37	37.83	0.4365	-0.0047	0.2058	-0.00042
NLW	26.21	27.91	32.42	0.4042	-0.004282	0.1432	-0.0002845

	b_1	b_2	b_3	y2011	y2012	y2013	y2014
NLB	-0.303	-0.238	0	-0.03413	0.23275	-0.0771	0
NLW				-0.01423	0.1085	-0.0424	0

The relationships follow a quadratic shape forming a maximum when liveweight at joining is 45-kg and NLB and NLW decrease if animals are heavier (Figure 27 and 28). In the modelling the reduction above 45-kg was removed and animals that were heavier than 45-kg were assumed to achieve the maximum NLB or NLW for their age at joining.

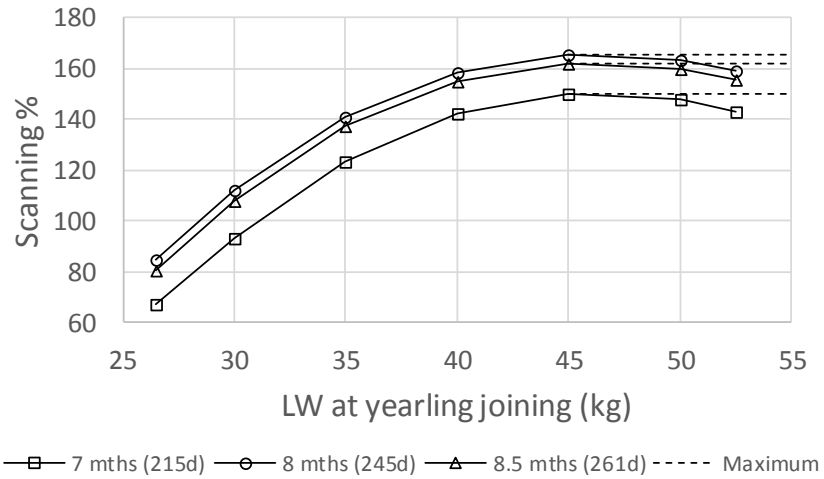

Figure 27: Relationship (with weighted average birth type) between reproductive rate (number of lambs scanned) and liveweight and age at joining (Source: Cashmore dataset). Dashed lines show the relationship used for animals greater than 45-kg at joining

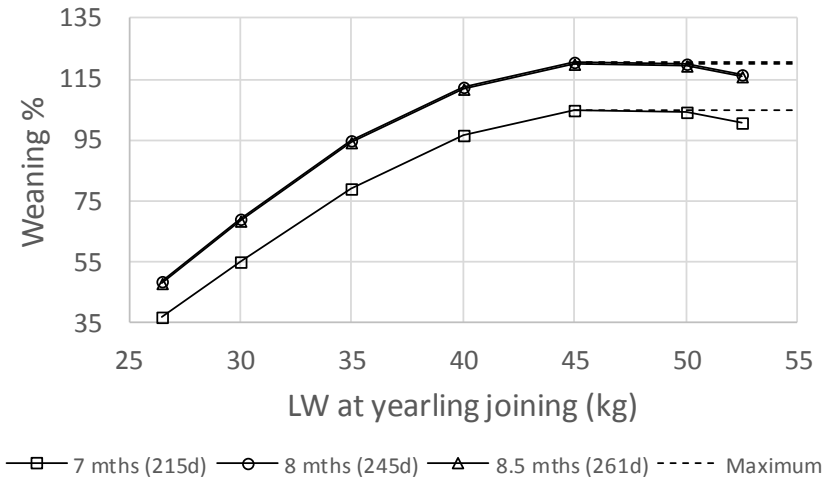

Figure 28: Relationship (with weighted average birth type) between number of lambs weaned and liveweight and age at joining (Source: Cashmore dataset). Dashed lines show the relationship used for animals greater than 45-kg at joining

The above predicted performance achieved from ewe lambs is higher than the reproduction estimated for 2 year old ewes in the standard model farm. Therefore, both NLB and NLW was scaled down so that NLW if joined at 8 months of age, at 45-kg and gaining 100 g/head/day during joining was 20% lower than the 2 year old ewes if joined at their SRW. The autumn lambing flock was then scaled down a further 10% to reflect that the ewes are not being joined out of the normal breeding season. Even with the above scaling applied these new relationships predict a higher reproductive rate and NLW than the relationships used in the original modelling (L.LSM.0001) and this will increase expected profitability.

4.1.2.2 Response in reproduction to selecting animal to join based on liveweight

In the previous economic analysis, it was assumed that increasing liveweight at joining by culling animals had half the impact of increasing liveweight at joining through feeding. This was based on the expectation that culling the lighter animals will cull a higher proportion of the multiple born lambs and these are the animals with a higher reproductive potential.

However, if there is an effect of age at joining on reproductive rate that is independent of liveweight at joining (see Figure 27) then the estimation of the response of selection on liveweight becomes a trade-off between selecting the older animals which have a higher reproductive rate and selecting the single born animals that have a lower reproductive rate at any given liveweight. Therefore, for this analysis it was assumed that the impact of selecting animals that have a higher liveweight will follow the same relationship whether the increase is due to nutrition or due to selection.

When the heavier ewes are selected at weaning it was assumed that the extra liveweight could be due to either genetically heavier animals or animals that were born earlier but are genetically similar. To reflect that some of the animals are genetically heavier the simulation of the selected animals included an increase in SRW. This increase ensured the simulation accounted for these animals remaining heavier through to joining rather than an impact of age which would diminish as the animals got older.

When selecting the weaners to be targeted for joining it was assumed that the variation in LW at joining will be reduced and therefore selecting the heaviest animals at joining will have less impact. The assumed response in LW at joining to selection at joining with different proportion selected at weaning is outlined in Table 9. The tabulated response is added to the liveweight that was predicted in the simulation model to give the liveweight used in the prediction of NLB and NLW for the ewe lambs.

Table 9: Liveweight of the animals selected for joining relative to the flock average (increase kg) when varying proportions have been targeted at weaning.

Proportion joined	Proportion retained in the breeding flock at weaning			
	25%	50%	75%	100%
25%	5.9	7.1	8.3	9.5
50%	3.7	4.4	5.1	5.9
75%	2.0	2.4	2.8	3.2
100%	0.0	0.0	0.0	0.0

4.1.3 The Analysis

The analysis was carried out as a series of sensitivity analyses. The factors examined and the mechanism by which they affect profitability are outlined below:

1. Age at joining: Two levels were evaluated: 7 month old and 8 month old.

   Delaying joining has four effects that impact profitability:

   i. Increases the proportion of the ewe lambs that have reached sexual maturity which increases the expected NLW at a given joining liveweight.
   ii. It increases the time available for the ewe lamb to gain weight prior to joining. If the feed supply is conducive to gaining weight then this is likely to increase NLW and will be additive to the effects of (a) above.
   iii. Reduces the time available for the ewe lambs to recover from lambing and be at a mating condition for mating as a 2 year old.
   iv. Reduces the time on high quality green feed for the progeny of the ewe lambs and this is likely to increase the cost of finishing the yearling progeny.

2. Proportion of the ewe lamb drop that is joined. This was a combination of the proportion targeted at weaning and the proportion selected at joining from those targeted. The levels evaluated were:
   a. Proportion of ewe lambs selected at weaning to be targeted for joining. 25%, 50%, 75% and 100% based on weaning liveweight.
   b. Proportion of the ewe lambs targeted that are mated. 25%, 50%, 75% and 100% selected at joining based on pre-joining liveweight.

   Altering the proportion of ewe lambs that are targeted for joining and the proportion of these that are joined has 4 effects that impact profitability:

   i. Selecting a proportion of the ewes to be mated based on liveweight increases the potential NLW achieved and selecting the ewes at joining has a greater effect than selecting the ewes at weaning. However, this effect is small for Maternals because the

response of NLW to liveweight at joining is asymptotic and does not increase above 45-kg.

ii. Targeting only a proportion of the ewe lambs will reduce feeding cost if the targeted ewes are being fed to achieve a higher weight at joining than ewes that won't be mated. However, in most of the scenarios there is not any differential feeding during the weaning to joining period and therefore targeting the heavier weaners does not alter feeding costs at this time.

iii. The cost of feeding the ewes could also be reduced if the ewes joined are fed more during joining or during pregnancy. Extra feeding occurs between joining and scanning for the autumn lambing flocks because for these flocks the not mated ewes can lose liveweight whereas the mated ewes are fed for maintenance. In the spring lambing flocks both groups of ewes are being fed for maintenance.

iv. The number of rams required is reduced and hence the cost of rams is reduced. If rams are used at 2.5%, cost $750/head to purchase and are used for three seasons then the cost per ewe mated is $6/ewe.

v. Not mating reduces the costs incurred in scanning the yearlings. It was assumed that the yearlings were scanned for litter size at a cost of $0.80/head

3. Nutrition profile. Thirty nutrition profiles were evaluated being a combination of:
   a. Nutrition from weaning to joining. Five levels were evaluated with the level depending on the feed supply in the region. The approximate targets were 65, 70, 75, 80 and 85% of SRW achieved by joining at 7 or 8 months. This leads to an increase in weaning percentage as outlined previously.
   b. Nutrition during the 35 days of joining. Two levels of liveweight gain were compared, being approximately maintenance and gaining 100 g/head/day. Gaining weight during joining increases NLB by 20% and NLW by 13%. Extra feeding during joining is profitable if the extra lambs weaned outweigh the cost of the supplement.
   c. Nutrition from weaning to joining at 19 month old, achieving different proportion of SRW by joining at 19 month old.

   Altering the nutrition profile for the ewes between weaning and joining at 19 months of age can have three impacts on profitability:

   i. Changing the liveweight at joining will alter the NLB and NLW of the respective age groups.

   ii. Changing the nutrition profile alters the feed requirements of the animals. This will reflect in the optimum stocking rate or quantity of supplementary grain feeding required. There can be interactions between the nutrition profile selected and the optimum management such as the profitability of retaining dry yearlings or the proportion of ewes to target at weaning and the proportion to mate.

   iii. The death rate of the ewes may vary if the ewes are at a low condition score during lambing.

4. Management of dry ewe lambs. The two options examined were retaining drys or selling dry ewe lambs at scanning as a prime lamb.

a. The opportunity of selling the dry yearlings at scanning was examined to determine if this increased the profitability of feeding the ewes to achieve higher liveweights at joining, such that the ewe lambs that were fed extra but that didn't get pregnant could be sold as a high value product. It is expected that selling the ewe lambs at scanning would be out of season and would attract a premium price of an extra $0.50/kg.
b. Selling the drys increases subsequent reproduction as a response in the current generation. It was assumed that scanning in later years would increase by 2.7% if drys were sold.
c. Selling the dry ewes at scanning results in getting no wool income from these animals compared to retaining them through and getting a full value hogget fleece. This effect is much less important for the maternal genotype than a merino genotype.
d. The impact on the feed budget of the farm depends on the time of sale compared with the break of season. If scanning is occurring after the break then the main feed shortage is over and there is less feed benefit from selling the dry animals. If scanning is occurring prior to the break then selling the drys may allow a greater number of reproducing ewes to be carried.
e. Selling the dry ewes may affect the ability of the flock to be self-replacing or it may require the older ewes to be retained for an extra year. In this analysis this wasn't incurred because it was assumed that the adult flock was achieving greater than 100% weaning rate and therefore there are a large number of surplus young ewes.

5. Genotype. The levels evaluated were: +/- 15% for NLB with a corresponding +/- 10% for NLW. Altering the genotype of the sheep was represented by a vertical adjustment in the relationship between NLW and liveweight at joining. It was assumed that this was the only change in the genotype and that other traits remained the same. This is not a realistic assumption but was used to isolate the value of having a genotype that matures earlier or has other characteristics that increase reproduction when mated before 12 months of age.
    a. The main effect on profitability is the change in the number of progeny for sale
    b. Altering the genotype also impacts the feed requirement of the ewes during pregnancy and lactation as it affects the number of ewes pregnant and lactating. It also impacts the wool production of the ewe lambs due to the effect of pregnancy and lactation on wool growth.
6. Prices. The sensitivity to changing both meat and wool prices were examined. When changes were made, the price of all sale sheep were changed by the same percentage or the price of all different quality of wool were changed by the same percentage;
    a. Wool: +/- 25%
    b. Meat: +/- 25%.

4.2 Results and Discussion

4.2.1 Great Southern spring lambing

Mating the ewe lambs to reproduce as a yearling increased profitability by $101,700/farm ($102/ha) (Table 10). This equates to $56 per yearling joined. This was associated with mating the whole drop of the 1,809 ewe lambs at 42-kg and achieving a weaning percentage of 96%. This produced 1,740 first cross lambs and increased the number of lambs produced on the farm by about 1,600 head (or 1.6 extra lamb per WG ha). An extra 7.2 kg/DSE of grain was fed, spread between finishing the progeny of the yearlings and feeding the yearling ewes prior to lambing and during lactation.

Table 10: Profitability and optimum management for the farm without and with mating yearling ewes. Note: The farm including mating ewe lambs has the optimum management as outlined in the text.

		Ewe Lambs Joined	
		Excluded	Included
Whole farm Profit	$/farm	71424	173129
	$/ha	71	173
Total Stock Numbers	DSE	8215	9039
	DSE/WG ha[1]	8.2	9.0
Grain Feeding	t	50.4	120.3
	kg/DSE	6.1	13.3
Pasture production	t/ha	7.5	7.8
Sale age of CFA ewes	years	5.5	5.5
Sale age of wethers	age	0.5	0.5
No. of adult ewes	head	3287	3153
No. of hoggets-Not mated		1875	0
Mated	head		1809
Number of lambs weaned	head	3947	5549
Weaning rate whole flock	%[2]	120%	112%
	lambs/WG ha	3.9	5.5
Yearling reproduction			
Age at joining	Months		8.5
LW joining	kg	35.1	42.2
LW lambing	kg	48.7	51.7
Scanning %	%		128.9
Weaning rate	%		96.2

1. WG ha = winter grazed hectare
2. Lambs weaned per ewe mated

The optimum system when joining ewe lambs was mating 100% of the drop at 8 months old, offering more feed from weaning to joining (such that they weigh about 7-kg more if they are going to be joined), aiming for 100 g/head/day liveweight gain during joining, selling the dry ewes and aiming for 100% of SRW for mating at 19 month old.

4.2.1.1 Age at joining

SW Victoria is a long growing season environment and green feed is available to contribute to finishing the later born lambs. If the ewe lambs were mated at 7 months of age rather than 8 months then

profit was reduced by $12,700 ($7/yearling). There is a moderate payoff from delaying mating of the young ewes to increase the proportion that have reached sexual maturity. The optimum ration pre-joining for the ewe lambs being mated is to be gaining weight and therefore delaying joining is increasing LW at joining and further increasing the number of lambs weaned.

4.2.1.2 Genotype

Having a genotype that achieves a higher reproduction from the ewe lambs increases profitability by $10,000 for a 10% increase in NLW. This equates to a net value of $55/extra lamb. This is a lower value than has been estimated elsewhere for the value of extra maternal genotype lambs from adult ewes. This reduction reflects the lower weaning weight and growth rates of the yearling progeny and the cost of finishing the lambs that are born later.

4.2.1.3 Selling dry yearlings

Selling the dry yearling ewes as prime lamb increases profitability by $3,850 or $17.50 per dry ewe sold. At scanning the dry ewes are weighing over 45-kg and would be a saleable prime lamb product at an out of season premium price. Retaining the dry ewe lambs till shearing is not as valuable as for merinos because of the lower fleece value and although scanning is occurring after the break of the season and the main feed shortage has passed there is still some benefit in reducing grazing pressure on the farm.

4.2.1.4 Liveweight change during joining

In the spring lambing analysis for the Hamilton farm the two options examined for liveweight change during joining were maintenance and gaining 100 g/head/d. Gaining the extra weight increased profit by $3,175 or $1.75/yearling joined. At the start of joining the ewe lambs are weighing just over 40-kg and therefore have unfilled potential for liveweight gain, however the timing of joining after the break of the season means that feeding grain is only moderately efficient for weight gain. Therefore, the value of the extra weaning percentage expected is similar to the cost of the grain required and flushing the ewes during joining is only slightly profitable.

4.2.1.5 Proportion of ewes mated

Mating a greater proportion of the drop increased profitability (Figure 29) and there was little effect of the proportion of ewe lambs targeted at weaning. Little or no difference due to the proportion targeted is expected because the most profitable system was feeding very similar quantities to the mated and non-mated lambs prior to joining, so there was little saving of feed from targeting only some ewe lambs.

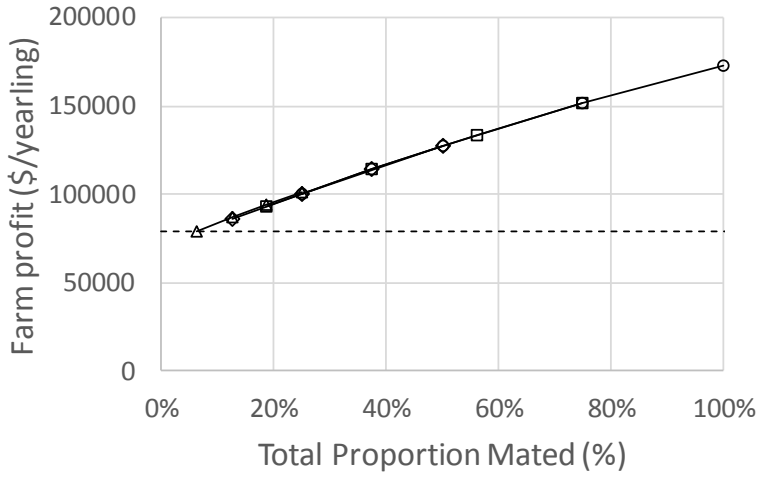

Figure 29: Impact on profitability of varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (Δ 25%, ◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

The linear increase in profit with increasing proportion mated reflects the lack of response in NLW to only mating the heavier ewe lambs. This is a different result than is achieved with the merinos and occurs because the number of lambs weaned per yearling does not increase as a result of increasing liveweight at joining above 45-kg (Figure 27). With the optimal level of nutrition the ewe lambs are 42.2-kg at joining so the potential increase in NLW due to selecting the heavier ewes to mate is less than 3%.

4.2.1.6 Nutrition from weaning to yearling joining

Feeding the ewe lambs extra after weaning to achieve a higher weight at joining increases profit up to 70% of SRW (Figure 30). Below 70% the increase in profit is $22/ewe lamb for each extra 10-kg gained. In SW Victoria with July/August born lambs that are weaned in early November there is extra high-quality green feed that is beyond the requirements of maintaining a dry weaner. Therefore, it is possible to reallocate feed on the farm to the weaners that are to be mated.

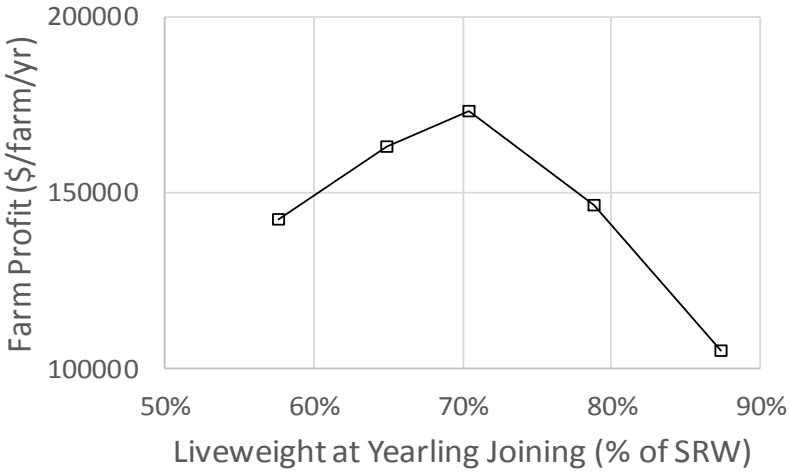

Figure 30: Impact on profit if ewe lambs are fed to achieve different liveweight at joining.

Extra liveweight gain above 70% of SRW must be achieved using supplementary feeding after pasture senescence. Profitability reduces which is a combination of increased cost of supplementary feed and diminishing improvement in NLW with further increases in joining weight, especially above 75% of SRW when NLW plateaus (Figure 31).

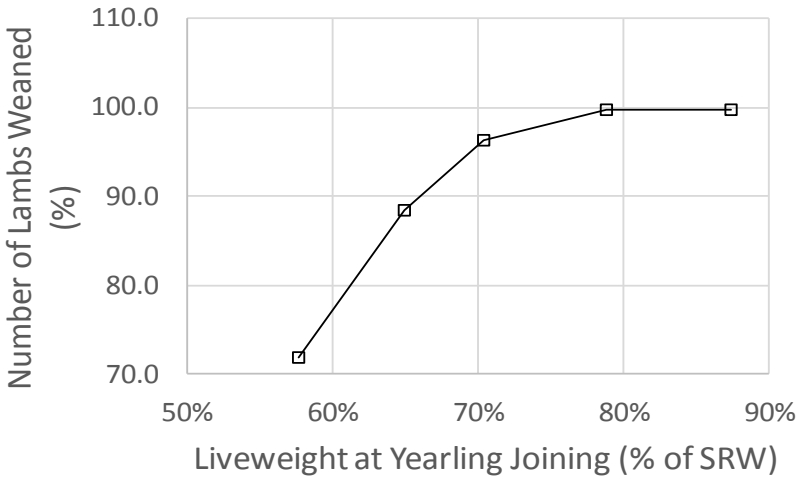

Figure 31: Impact on number of lambs weaned from increasing liveweight at joining.

4.2.1.7 Nutrition of the yearling post weaning

Feeding the yearling ewes extra during the recovery period from weaning to their 2 year old joining also increases profitability (Figure 32). Part of the liveweight gain can be achieved on green feed that is not fully utilised because the feed limiting period is occurring earlier in the autumn/winter period, however, part is achieved using supplementary feeding after pasture senescence. The increase in profit per unit increase in liveweight ($16.80 per 2 year old ewe for 10-kg) is less for the yearlings gaining weight than it is for ewe lambs gaining weight prior to joining indicating that the ewe lambs are a higher priority than the older ewes.

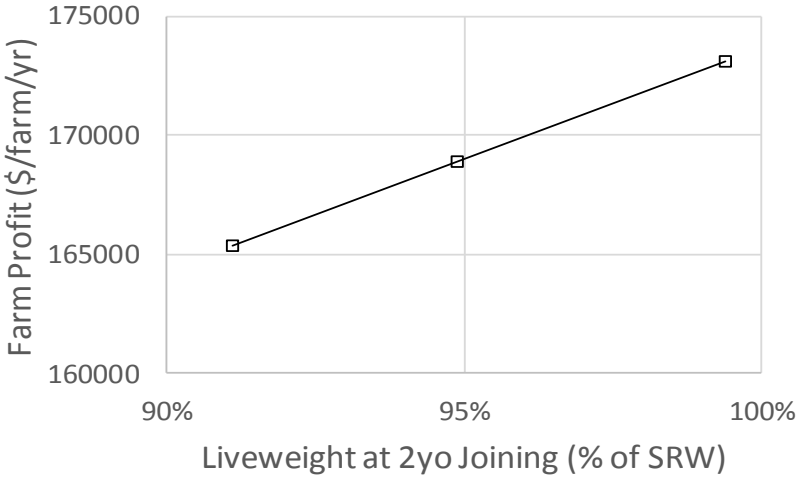

Figure 32: Variation in farm profit and the effect of varying the recovery of the yearling ewes after weaning their lambs.

4.2.1.8 Sensitivity to meat and wool price

The profitability of mating ewe lambs increases as meat price increases but is insensitive to the price of wool (Figure 33). For each $1/kg change in the price of lamb the profitability of mating ewe lambs increased by $35,000 per farm. If the price of prime lamb increases to $7/kg then the benefit increases to more than $170,000 per year.

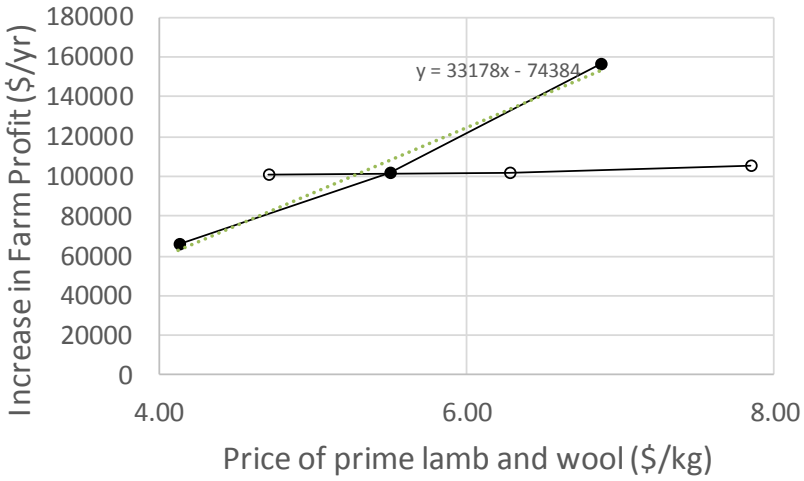

Figure 33: Change in profit from joining ewe lambs if meat price (●) or wool price (○) changes by 25%.

4.2.2 South West Victoria autumn lambing

Mating the ewe lambs to reproduce as a yearling increased profitability by $90,000/farm ($90/ha) (Table 11). This equates to $57 per yearling joined. This was associated with mating the whole drop of the 1,576 ewe lambs at 45-kg and achieving a weaning percentage of 83%. This produced 1,301 first cross lambs and increased the number of lambs produced on the farm by about 1,306 head (or 1.3 extra lambs per WG ha). An extra 2.9 kg/DSE of grain was fed, spread between finishing the progeny of the yearlings and feeding the yearling ewes prior to lambing and during lactation.

The optimum system when joining ewe lambs was mating 100% of the drop at 8 months old, offering the same feed from weaning to joining for the lambs being mated as those not mated, aiming for 100 g/head/day liveweight gain during joining, selling the dry ewes and aiming for more than 100% of SRW for mating at 19 month old.

Table 11: Profitability and optimum management for the farm without and with mating yearling ewes. Note: The farm including mating ewe lambs has the optimum management as outlined in the text.

		Ewe Lambs Joined	
		Excluded	Included
Whole farm Profit	$/farm	39641	129929
	$/ha	40	130
Total Stock Numbers	DSE	6993	7862
	DSE/WG ha[1]	7.0	7.9
Grain Feeding	t	34.1	61.4
	kg/DSE	4.9	7.8
Pasture production	t/ha	7.0	7.2
Sale age of CFA ewes	years	5.5	5.5
Sale age of wethers	age	0.5	0.5
No. of adult ewes	head	2856	2839
No. of hoggets-Not mated		1574	0
Mated	head		1576
Number of lambs weaned	head	3313	4619
Weaning rate whole flock	%[2]	116%	105%
	lambs/WG ha	3.3	4.6
Yearling reproduction			
Age at joining	Months		8.5
LW joining	kg	42.5	44.8
LW lambing	kg	46.9	50.2
Scanning %	%		108.1
Weaning rate	%		82.6

1. WG ha = winter grazed hectare
2. Lambs weaned per ewe mated

4.2.2.1 Age at joining

If the ewe lambs were mated at 8 months of age rather than 7 months then profit was increased by $1,600 or $1.00/ewe lamb joined. This is only a modest improvement and the increase in the number of lambs weaned that is achieved from delaying joining to increase the proportion that have reached sexual maturity is offset by the cost of finishing the later drop lambs. Joining at 7 months of age means that there is a longer period of green feed available to finish the progeny from the ewe lambs, reducing the finishing costs compared with the progeny of ewe lambs joined at 8 months old. Furthermore, when lambing in autumn the ewe lambs have 2 or 3 months of green feed after weaning to gain liveweight and can achieve good weights prior to joining. Delaying joining to 8 months of age and gaining further liveweight has only a limited impact on increasing NLW (Figure 28).

4.2.2.2 Genotype

Having a genotype that achieves a higher reproduction from the ewe lambs increases profitability by $7,370 ($4.90/ewe lamb) for a 10% increase in NLW. This equates to a net value of $49/extra lamb produced. This is a lower value than has been estimated elsewhere of the value of extra lambs from adult ewes, and slightly lower than the value of an extra lamb for a spring lambing flock in the same region. This reduction reflects the extra costs associated with having the yearlings pregnant and lactating during early winter in this scenario.

4.2.2.3 Selling dry ewe lambs

Selling the dry ewe lambs as prime lamb increase profitability by $6,920 or $21 per dry ewe lamb sold. At scanning the dry ewe lambs are weighing about 44-kg and are a saleable product at a premium price. Scanning is occurring near the break of the season so selling the dry ewe lambs only has a minimal impact in allowing the flock size to be increased. This increase in stocking rate and the premium sale price outweighs the small loss in wool cut from the dry animals.

4.2.2.4 Liveweight change during joining

In the autumn lambing analysis for the Hamilton farm the two options examined for liveweight change during joining were maintaining weight and gaining 100 g/head/day. Gaining the extra weight increased profit by $8,500 or $5.40/ewe lamb joined. At joining the ewe lambs are weighing about 45-kg and joining is occurring during late autumn when the quality of the dry feed is low and therefore substitution of grain for dry pasture is low. Together these factors make it less expensive to feed grain to gain weight and therefore flushing the ewes during joining is profitable.

4.2.2.5 Proportion of ewes mated

Mating a greater proportion of the drop increased profitability (Figure 34) and there was little effect of the proportion of ewe lambs targeted at weaning. Little or no difference due to the proportion targeted is because the most profitable system was feeding very similar quantities to the mated and non-mated lambs prior to joining, so there was little saving of feed from targeting only some lambs.

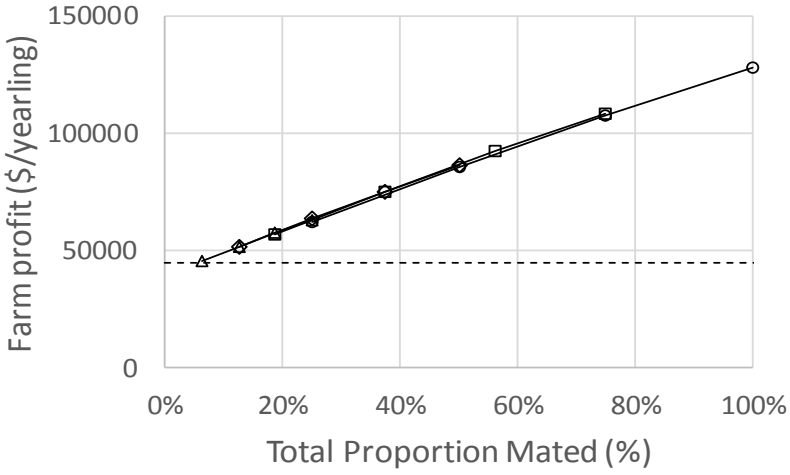

Figure 34: Impact on profitability of varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (Δ 25%, ◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

The linear increase in profit with increasing proportion mated reflects the lack of response in NLW to only mating the heavier ewe lambs. This is a different result than is achieved with the merinos and occurs because the number of lambs weaned per yearling doesn't increase as a result of increasing LW at joining above 45-kg (Figure 28).

4.2.2.6 Nutrition from weaning to yearling joining

Feeding the ewe lambs extra after weaning to achieve a weight at joining greater than 75% of SRW reduces profit (Figure 35). The reduction in profit is $6.60/ewe lamb for each extra 1-kg gained. In the Hamilton region with May born lambs that are weaned in mid-August the weaners have access to high quality feed post weaning. Some extra liveweight can be achieved by reallocation of feed but beyond that level extra liveweight can only be achieved through extra supplementary feeding. The supplementary feeding is occurring in late spring and early summer when feed quality and availability is high and therefore the level of substitution of supplement for grain is expected to be high. Furthermore no increase in NLW is achieved from gaining liveweight above 45-kg (75% of SRW) at joining.

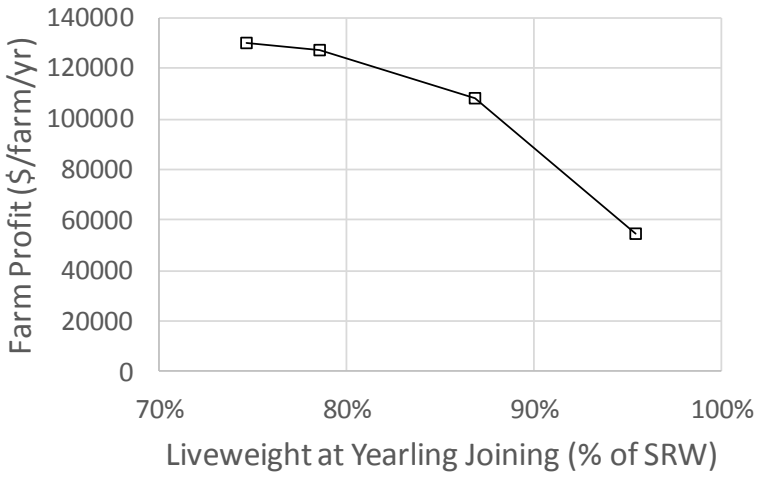

Figure 35: Impact on profit if ewe lambs are fed to achieve different liveweight at joining.

4.2.2.7 Nutrition of the yearling post weaning

Feeding the yearling ewes extra during the recovery period from weaning to their 2 year old joining increases profitability (Figure 36). Liveweight gain at this time of year is achieved on green feed and further liveweight gain is difficult to achieve and is from reallocating the high quality pasture to the maiden ewes. The increase in profit per unit increase in liveweight ($13.80 per 2 year old ewe for 10-kg) is slightly less than extra weight in a spring lambing flock that is partly achieved from supplementary feeding. In this scenario the value is reflecting the opportunity of redirecting high quality pasture from the mature ewes.

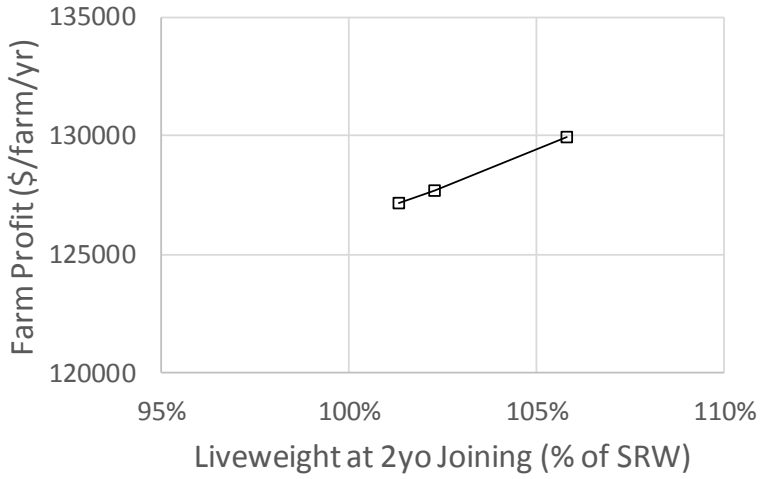

Figure 36: Variation in farm profit and the effect of varying the recovery of the yearling ewes after weaning their lambs.

4.2.2.8 Sensitivity to meat and wool price

The profitability of mating ewe lambs increases as meat price increases but is insensitive to the price of wool (Figure 37). For each $1/kg change in the price of lamb the profitability of mating ewe lambs increased by $28,000 per farm. If the price of prime lamb increases to $7/kg then the benefit increases to about $140,000 per year.

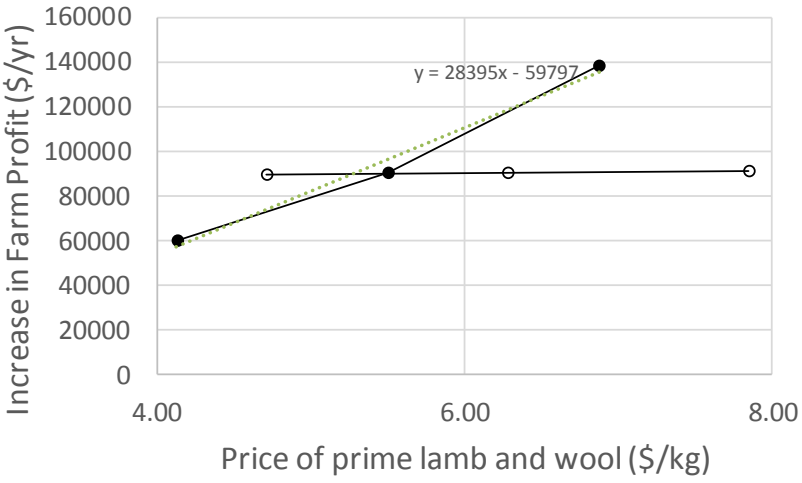

Figure 37: Change in profit from joining ewe lambs if meat price (●) or wool price (○) changes by 25%.

4.2.3 Great Southern autumn lambing

Mating the ewe lambs to reproduce as a yearling increased profitability by $75,500/farm ($35/ha or $59/WG ha) (Table 12). This equates to $33 per ewe lamb joined. This was associated with mating 100% of the drop of 2,318 ewe lambs at 44-kg and achieving a weaning percentage of 81%. This produced 1,883 first cross lambs. The lambs produced increased by 1,329 head or 1.0 per hectare of pasture. Stocking rate was reduced by 0.9 DSE/ha and level of grain feeding increased by 12.5 kg/DSE.

Table 12: Profitability and optimum management for the farm without and with mating yearling ewes. Note: The farm including mating ewe lambs has the optimum management as outlined in the text.

		Ewe Lambs Joined	
		Excluded	Included
Whole farm Profit	$/farm	289581	365104
	$/total ha	136	171
Crop Area	%	40%	40%
Total Stock Numbers	DSE	11109	12242
	DSE/WG ha[1]	8.7	9.6
Grain Feeding	t	621.9	838.7
	kg/DSE	56.0	68.5
Pasture production	t/ha	6.7	6.8
Sale age of CFA ewes	years	5.9	5.5
Sale age of wethers	age	0.46	0.46
No. of adult ewes	head	5280	4665
No. of hoggets-Not mated		1375	0
Mated	head		2318
Number of lambs weaned	head	5435	6764
Weaning rate whole flock	%[2]	103%	97%
	lambs/WG ha	4.25	5.29
Yearling reproduction			
Age at joining	Months		8.5
LW joining	kg	43.0	44.4
LW lambing	kg	36.8	43.9
Scanning %	%		108.1
Weaning rate	%		81.2

1. WG ha = winter grazed hectare
2. Lambs weaned per ewe mated

The optimum system when joining ewe lambs was mating 100% of the drop at 8 months old, offering the same feed from weaning to joining for the lambs being mated as those not mated, aiming for 100 g/head/day liveweight gain during joining, selling the dry ewes and aiming for 100% of SRW for mating at 19 months old.

4.2.3.1 Age at joining

If the ewe lambs were mated at 7 months of age rather than 8 months then profit was reduced by $25,500 or $11/yearling mated. The increased profitability was associated with a 30% increase in the number of lambs weaned from the yearling ewes. This increase was due mostly to the increase in the proportion of ewes that had reached sexual maturity but also an increase in joining weight. The early joining in this scenario means that there is still green feed available at weaning to finish the progeny from the ewe lambs, reducing the extra costs associated with finishing the later born lambs.

4.2.3.2 Genotype

Having a genotype that achieves a higher reproduction from the ewe lambs increases profitability by $12,150 for a 10% increase in NLW. This equates to a net value of $58/extra lamb produced.

4.2.3.3 Selling dry yearlings

Selling the dry ewe lambs as prime lamb increases profitability by $9,300 or $24 per dry ewe lamb sold. The high value per dry ewe is because scanning is occurring before the break of the season and the main feed shortage, therefore selling the dry ewe lambs would allow the flock size to be increased.

4.2.3.4 Liveweight change during joining

In this autumn lambing analysis for the Great Southern farm the two options examined for liveweight change during joining were maintaining liveweight and gaining 100 g/head/day. Gaining the extra weight increased profit by $7,900 or $3.40/yearling joined. At joining the ewe lambs are weighing about 44-kg and joining is occurring during late summer when the quality of the dry feed is moderate and therefore substitution of grain for dry pasture is medium. Together these factors make it moderately expensive to feed grain to gain weight and therefore flushing the ewes during joining has medium profitable.

4.2.3.5 Proportion of ewes mated

Mating a greater proportion of the drop increased profitability (Figure 38) and there was little effect of the proportion of ewe lambs targeted at weaning. Little or no difference due to the proportion targeted is because the most profitable system was feeding very similar quantities to the mated and non-mated lambs prior to joining, so there was little saving of feed from targeting only some lambs.

The linear increase in profit with increasing proportion mated reflects the lack of response in NLW to only mating the heavier ewe lambs. This is a different result than is achieved with the merinos and occurs because the number of lambs weaned per yearling doesn't increase due to increasing liveweight at joining above 45-kg (Figure 28).

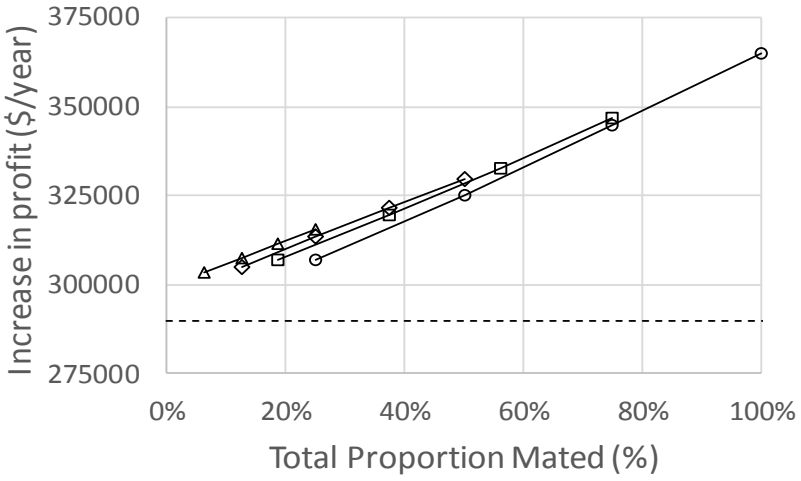

Figure 38: Impact on profitability of varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (Δ 25%, ◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

There is almost no improvement in weaning percentage (Figure 39) when the proportion of ewes mated is reduced even though the liveweight of the cohort that are mated increases. This is associated with the relationship between liveweight at joining and weaning percentage that shows a maximum weaning percentage occurring with a joining weight of 45-kg (Figure 28).

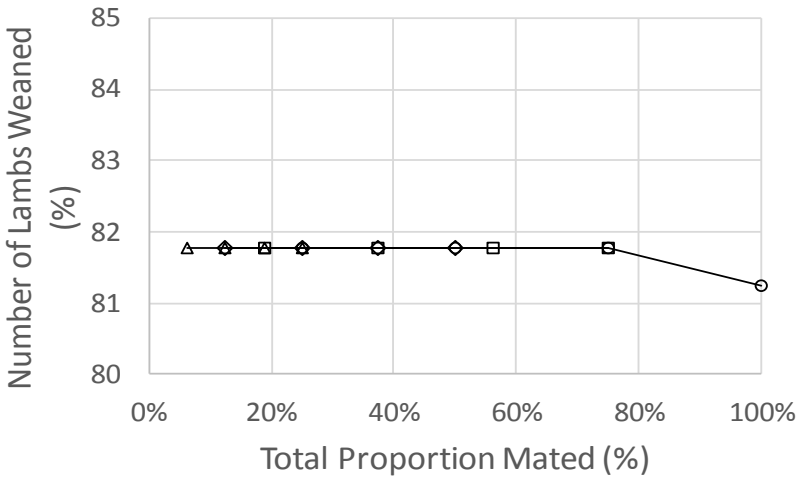

Figure 39: Impact on the average number of lambs weaned from ewe lambs when varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

4.2.3.6 Nutrition from weaning to yearling joining

Feeding the ewe lambs extra after weaning to achieve a higher weight at joining reduces profit (Figure 40). Joining is occurring at the period of the year at or just after peak liveweight, therefore high rates of supplement need to be fed for the animals to gain liveweight. Furthermore, the ewe lambs are achieving mating liveweight of 45-kg (75% of SRW) with minimal supplementary feeding post weaning and above this weight there is no response in increasing NLW.

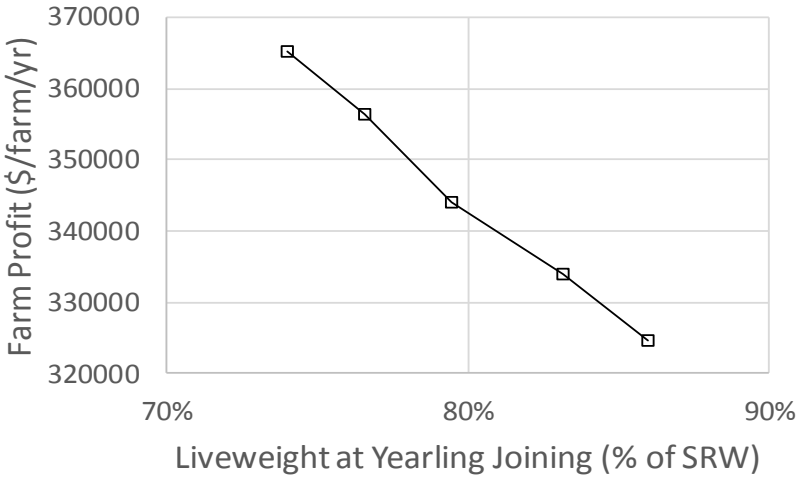

Figure 40: Impact on profit if ewe lambs are fed to achieve different liveweight at joining.

4.2.3.7 Nutrition of the yearling post weaning

Feeding the yearling ewes extra during the recovery period from weaning to their 2 year old joining increases profitability (Figure 41) by $2.50/hogget ewe per 10-kg of liveweight gain. The older ewes do respond to increased liveweight at joining and the majority of the increase can be achieved through altering the allocation of green feed and only a small amount of supplementary feeding is required.

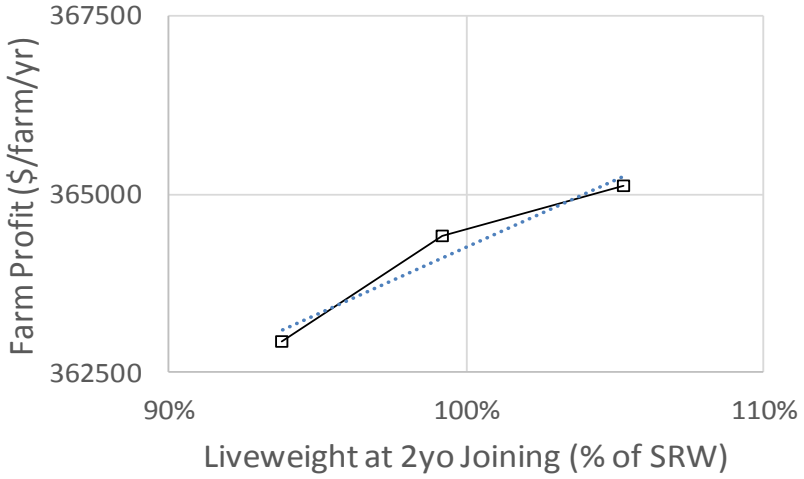

Figure 41: Variation in farm profit and the effect of varying the recovery of the yearling ewes after weaning their lambs.

4.2.3.8 Sensitivity to meat and wool price

The profitability of mating ewe lambs increases as meat price increases but is insensitive to the price of wool (Figure 42). For each $1/kg change in the price of lamb the profitability of mating ewe lambs increased by $25,000 per farm. If the price of prime lamb increases to $7/kg then the benefit increases to over $110,000 per year.

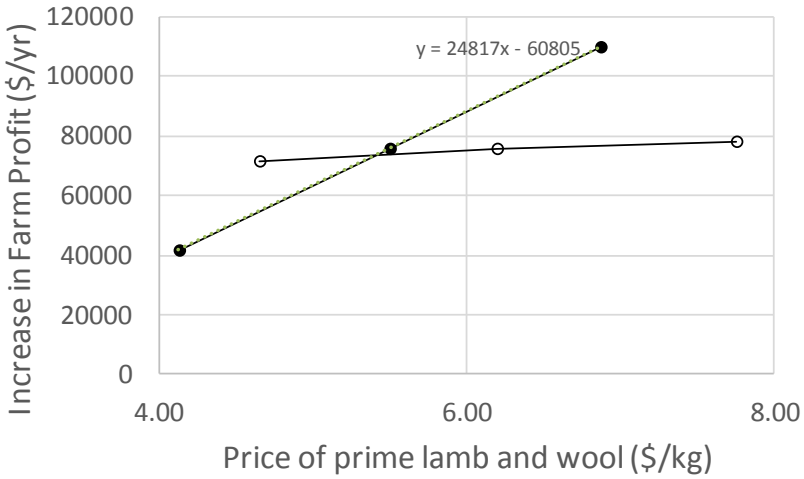

Figure 42: Change in profit from joining ewe lambs if meat price (●) or wool price (○) changes by 25%.

4.2.4 Central wheatbelt autumn lambing

Mating the ewe lambs to reproduce as a yearling increased profitability by $9,000/farm ($2.80/ha or $26/WG ha) (Table 13). This equates to $31 per yearling joined. This was associated with mating the whole drop of the 292 ewe lambs at 43-kg and achieving a weaning percentage of 78%. This produced 227 first cross lambs and increased the number of lambs produced on the farm by about 1.3 extra lamb per pasture ha. There was an increase in grain fed of 2.0 kg/DSE, an increase in stocking rate of 1.9 DSE/ha and an increase in the area of pasture of 4%.

Cropping is the main enterprise on wheatbelt farms in WA and as for merinos the contribution of mating ewe lambs to total profitability is minor. The different feed supply with extra supply of dry feed during summer and autumn doesn't increase the profitability of mating ewe lambs and doesn't offset the shorter growing season, as seen in the benefit per ewe lamb joined being least in this zone. Therefore, this zone is not a target zone for this technology, furthermore, farmers are unlikely to prioritise upgrading to the level of skill required to implement the system successfully.

Table 13: Profitability and optimum management for the farm without and with mating yearling ewes. Note: The farm including mating ewe lambs has the optimum management as outlined in the text.

		Ewe Lambs Joined	
		Excluded	Included
Whole farm Profit	$/farm	131589	140632
	$/ha	41	44
Crop Area	%	93%	89%
Total Stock Numbers	DSE	575	1570
	DSE/ha	2.5	4.4
Grain Feeding	t	17.2	50.0
	kg/DSE	29.8	31.9
Pasture production	t/ha	1.3	2.1
Sale age of CFA ewes	years	5.5	5.5
Sale age of wethers	age	0.5	0.5
No. of adult ewes	head	251	612
No. of hoggets-Not mated		117	0
Mated	head		292
Number of lambs weaned	head	247	841
Weaning rate whole flock	%[1]	98.5%	93.0%
	lambs/ha	1.1	2.4
Yearling reproduction			
Age at joining	Months		8.5
LW joining	kg	-	43.0
LW lambing	kg	-	44.2
Scanning %	%	-	105.6
Weaning rate	%	-	77.8

1. Lambs weaned per ewe mated

The optimum system when joining ewe lambs was mating 100% of the drop at 8 months old, increasing the feed supply from weaning to joining for the lambs being mated, aiming for 100 g/head/day liveweight gain during joining, retaining the dry ewes and aiming for 95% of SRW for mating at 19 months old.

4.2.4.1 Age at joining

If the ewe lambs were mated at 7 months of age rather than 8 months then profit was reduced by $7,300 ($25/ewe lamb), which is still slightly more profitable than not mating. The optimum ration pre-joining for the ewe lambs being mated is to be gaining weight and therefore delaying joining is increasing LW at joining and further increasing the number of lambs weaned beyond that achieved from the increased proportion that have achieved sexual maturity.

4.2.4.2 Genotype

Having a genotype that achieves a higher reproduction from the ewe lambs increases profitability by $2,150 for a 10% increase in NLW. This equates to a net value of $75/extra lamb produced. This is higher a higher value per head than the value calculated in the other regions and is due to the availability of stubbles in the central wheatbelt system. However, the low numbers of sheep per farm overrides the high value per head and the value per farm is still very low.

4.2.4.3 Selling dry yearlings

Selling the dry ewe lambs as prime lamb increases profitability by $900 or $14.25 per dry ewe lamb sold. At scanning the dry ewes are weighing about 45-kg and are a saleable product at a premium price. Furthermore, scanning is occurring prior to the break of the season and therefore selling the drys increases the number of other sheep that can be carried and this contributes to the high value per dry ewe sold.

4.2.4.4 Liveweight change during joining

In the autumn lambing analysis for the central wheatbelt the two options examined for liveweight change during joining were maintaining liveweight and gaining 100 g/head/day. Gaining the extra weight increased profit by $3,500 or $12/ewe lamb joined. Joining is occurring in early summer which is time of year when there is a high rate of substitution of extra supplement for dry pasture and stubble however, the higher value of extra lambs outweighs the cost and results in a high value per yearling from gaining LW during joining.

4.2.4.5 Proportion of ewes mated

Mating a greater proportion of the drop increased profitability (Figure 43), however, as for the other regions, there was little effect of the proportion of ewe lambs targeted at weaning. The increase in profitability is determined by overall proportion mated and not differentiated by the proportion targeted.

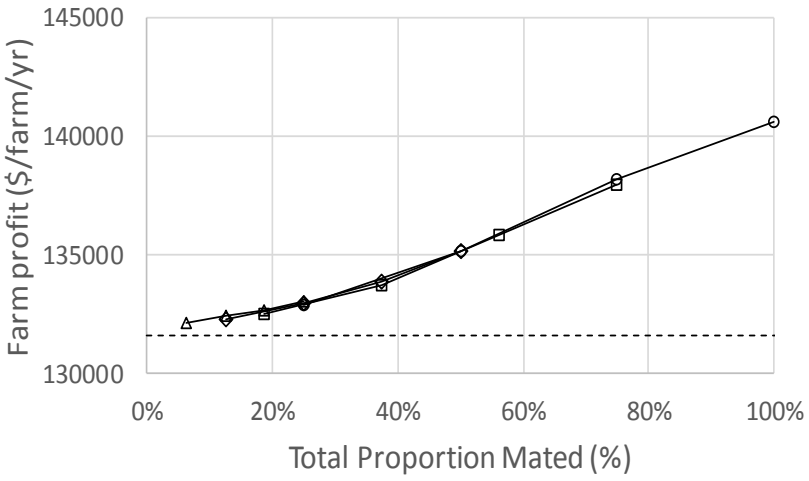

Figure 43: Impact on profitability of varying the proportion of ewe lambs mated by either altering the proportion targeted at weaning (Δ 25%, ◊ 50%, □ 75% and ○ 100%) and/or altering the proportion selected at joining.

4.2.4.6 Nutrition from weaning to yearling joining

Feeding the ewe lambs extra after weaning to achieve a higher weight at joining increases profit up to 72% of SRW (Figure 44). Increasing liveweight beyond this point reduces profitability because the cost of supplementary feed is not recouped and about 75% of SRW there is no increase in number of lambs weaned.

Figure 44: Impact on profit if ewe lambs are fed to achieve different liveweight at joining.

4.2.4.7 Nutrition of the yearling post weaning

Feeding the ewe lambs extra during the recovery period from weaning to their 2 year old joining has very little impact on profitability (Figure 45). The cost of the extra supplement required offsets the value of the extra lambs produced as a hogget.

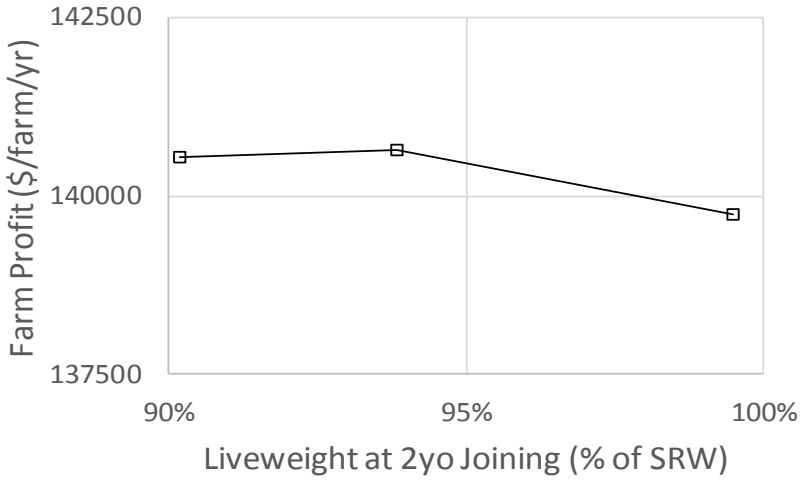

Figure 45: Variation in farm profit and the effect of varying the recovery of the yearling ewes after weaning their lambs.

4.2.4.8 Sensitivity to meat and wool price

Mating ewe lambs is more profitable if meat price increases and is less sensitive to the price of wool (Figure 46). If the price of prime lamb was below $4/kg it would not be profitable to mate ewe lambs and even above $7/kg for lamb the increase in profit is less than $20,000 per year.

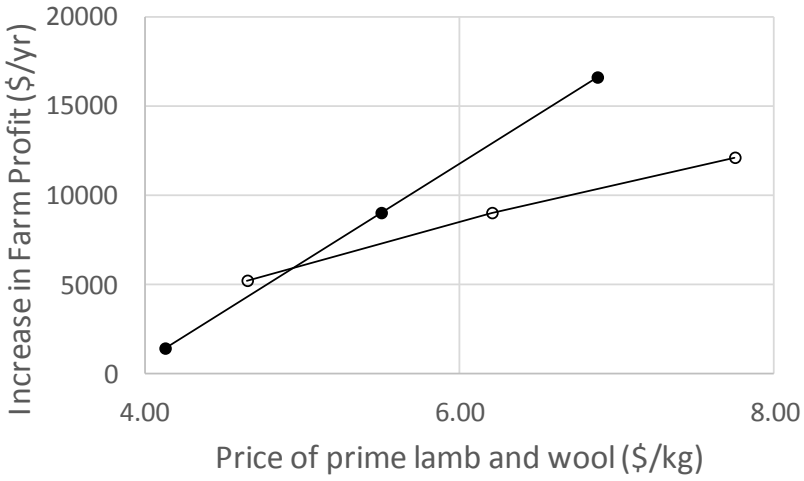

Figure 46: Change in profit from joining ewe lambs if meat price (●) or wool price (○) changes by 25%

4.2.5 Conclusions

Mating maternal ewe lambs was profitable in all regions and times of lambing that were examined. The increase in profit ranged from $31/ewe lamb joined in the short growing season environment up to $57/ewe lamb joined in the long growing season environment of SW Victoria. The longer the growing season is reducing the cost of raising the extra progeny particularly the growing out from weaning to sale as a prime lamb. The benefits in each scenario examined are greater than the benefits from mating Merino ewe lambs. This is related to the higher reproduction achieved by the maternal ewe lambs, the higher value of extra lambs born and the reduction in the cost associated with reduced wool growth.

For the Maternal genotype in the environments evaluated there is no incentive to target a proportion of the ewes at weaning or only select a proportion of the ewes at joining. It was most profitable to mate all the Maternal ewe lambs and unlike Merinos there was no indication that reducing the proportion of Maternals mated would be a useful tactic. The higher weights achieved at joining and the asymptotic relationship between liveweight at joining and NLW means that there is little increase in NLW from only mating the heavier ewe lambs.

In all analyses it was more profitable to join at 8 months of age rather than at 7 months. The increase in the proportion of lambs that have reached puberty and the subsequent increase in NLW outweighed the reduced recovery period prior to joining at 19 months of age and the reduction in the period of green feed for the grow out phase of the progeny. This is opposite to the findings for the Merino genotype and probably reflects that the extra growth potential of the maternal genotype can compensate for the reduce time available for recovery and growing the progeny.

The benefits achieved in the short growing season environments do not justify the investment in time required to skill up for the challenges of mating ewe lambs. The system is not suited to the short growing season and the supply of crop stubbles through summer and autumn doesn't offset this. Furthermore, the small flock sizes in this region do not justify the skilling up that would be required. In all scenarios it was profitable to sell the dry ewe lambs. This finding also contrasts with the merino scenarios and the main difference is the value of the wool produced by the dry animals. The maternal genotype has much less valuable wool and therefore selling the dry ewe lambs as a premium priced prime lamb in the out of season market increases profitability by between $14 and $24/ewe lamb sold.

The main role of this analysis is to provide the background understanding and the response curves that will be used in the decision support tool that can be used by farmers to consider whether to mate ewe lambs. The analysis was successful in achieving this aim and this analysis together with the analysis of maternal flocks will be combined when building the decision support tool.

4. Decision Support Tool

A decision support tool was developed for consultants and farmers who are currently not mating ewe lambs to help them decide whether mating ewe lambs is a technology that they should be evaluating. The tool '*Fitting mating ewe lambs into the production priorities*', synthesises information from a range of sources to estimate whether mating ewe lambs is a priority on the target farm or whether there are other production issues that are likely to have a higher pay-off. The production alternatives that are examined include: (i) Mating Ewe Lambs; (ii) Improving reproduction from mature ewes by achieving targets for conception, single lamb survival, twin lamb survival and or triplet lamb survival; (iii) Improving reproduction from 2 year old ewes; or (iv) Improving pasture production and utilisation. The DST also determines the optimal management of the flock if mating ewe lambs together with the impact on profitability if non-optimal management is followed.

4.1 Methodology

The increase in production and profitability expected for a self-replacing flock from achieving production targets for each of the above production alternatives was estimated. The profitability associated with increasing production from current farm levels up to the target was estimated from analyses previously carried out with the MIDAS model.

4.1.1 Mating Ewe Lambs

The potential profitability of mating ewe lambs was estimated from MIDAS analyses carried in project L.LSM.0007. The analysis quantified profitability of mating ewe lambs for a range of scenarios including:

1. Breed of sheep: Merino and Maternal
2. Length of growing season: SW Victoria – 8.5 months and Great Southern WA – 6 months.
3. Time of lambing: Autumn (0) and Spring (1)
4. ASBV for NLW of the ewe lambs: +/- 10%
5. Age of the ewe lamb at mating: 7 months and 8 months
6. Age when surplus young ewes are sold: Lambs (0) or Hoggets (1)
7. Liveweight at joining: as a proportion of the SRW of the breed
8. Liveweight change during the ewe lamb joining period: 0 and 100 g/head/d
9. Proportion mated: 50%, 75% and 100%
10. Management of the dry ewe lambs: Retain (0) or Sell (1)
11. Price expected for lamb: $4.50/kg up to $7.50/kg

A multiple regression was fitted to the analysis outputs including quadratic terms for LW at joining and the proportion mated, and first order interactions for all factors (Maternals, Table 14, Merinos Table 15). This allows interpolation of profitability between the points quantified in the analysis. The coefficients from the regression are used to estimate the profitability per ewe lamb for the target farm based on inputs provided by the user for each parameter. The regression coefficients can be used to calculate the optimum LW at joining and the optimum proportion of the ewe lambs to join.

Table 14: Coefficients for the multiple regression equation to predict increase in profit from mating maternal ewe lambs from environmental and management parameters, quadratic terms and first order interactions. The Intercept value was 267.14

	Length of GS	TOL	Sale age	Age joining	LW joining	LWC joining	NLW	Propn mated	Drys	Lamb price
Realistic range	6 – 9	0, 1	0, 1	7 – 8.2	60-80%	0-100	-25-+10%	50-100%	0, 1	4.5 - 7.5
Coefficient	-18.48	0.00	-28.34	-90.21	1011.59	-0.53	-15.06	7.94	-13.49	-21.4
Quadratic					-1145.8			-37.81		
First order interactions										
GS Len		5.00	0.02	2.07	4.55	0.01	-5.44	1.35	1.43	-0.13
TOL			11.15	7.50	-153.77	0.09	12.87	-17.29	-5.78	1.69
Sale age				-3.21	51.99	-0.05	-19.73	9.56	6.61	0.95
Age joining					84.07	-0.03	1.61	21.63	-0.87	0.94
LW joining						0.80	0.80	-247.6	-4.09	15.34
LWC							-0.03	0.12	0.01	0.01
NLW								88.37	-0.06	7.56
Propn									5.39	12.52
Drys										1.61

Table 15: Coefficients for the multiple regression equation to predict increase in profit from mating merino ewe lambs from environmental and management parameters, quadratic terms and first order interactions. The Intercept value was 0.0

	Length of GS	TOL	Sale age	Age joining	LW joining	LWC joining	NLW	Propn mated	Drys	Lamb price
Modelled range	6 – 8.5	0, 1	0, 1	7 – 8	60-85%	0-100	-10-+10%	50-100%	0, 1	4.5 - 7.5
Coefficient	30.55	547.75	-22.13	-57.12	-88.39	-0.09	-38.18	-168.5	-53.31	-17.8
Quadratic					-243.5			-13.38		
First order interactions										
GS Len		-101.2	4.91	4.98	33.88	-0.01	2.47	12.12	-1.13	0.18
TOL			-4.46	3.87	21.53	-0.01	-13.73	11.19	-1.39	0.68
Sale age				0.93	-15.39	0.00	-2.74	0.16	4.27	-0.39
Age joining					17.34	0.00	0.06	10.79	2.71	0.60
LW joining						0.13	-16.89	-41.53	24.08	12.99
LWC							0.01	0.04	0.03	0.01
NLW								41.80	12.31	8.15
Propn									-1.87	5.65
Drys										2.80

In the decision support tool calculation, a factor was added to account for the expected weaning percentage of the ewe lambs on the farm based on the difference between the actual and potential NLW for 2 year old ewes. This was to reflect that if the farmer is not achieving the potential for their 2 year old ewes then they are likely to underachieve if mating their ewe lambs.

The optimum mating age for the ewe lambs was dependent on the lambing time of the older ewes relative to pasture senescence. Joining the ewe lambs was delayed till up to 8 months of age if the later lambing allowed 4.5 months of green feed post lambing. The estimated value per ewe lamb was scaled by the number of ewe lambs available for joining on the target farm to get total value for the flock.

4.1.2 Reproduction from mature ewes and 2 year old ewes

The production targets for NLW were based on the potential industry productivity levels estimated by Trompf *et al.* (2018). A currently achievable level (presented in Table 16) was estimated as a shift of 75% from the current industry average levels of scanning and lamb survival to the potential levels identified by Trompf *et al.* (2018).

Table 16: The achievable level of scanning and lamb survival for the mature ewes and 2 year old ewes for both breeds.

	Maternal		Merino	
	Mature	2yo	Mature	2yo
Conception	178	151	151	131
Single survival	95	90	91	85
Twin survival	85	71	78	65
Triplet survival	73	56	58	45
Number of lambs weaned	150	113	121	94

These achievable levels were also adjusted based on the ASBV for NLW of the target flock. The adjustment was a combination of varying conception and lamb survival to achieve the variation in NLW. The change in the number of single, twin and triplet animals weaned was calculated for the target flock if their reproduction levels increased to these targets. The impact on profitability was then calculated using the value of single and twin born lambs from Young *et al.* (2014). The value of a triplet born lamb was based on Young (unpublished data).

4.1.3 Pasture production and utilisation

The calculation of the potential to increase pasture production and utilisation was based on improvements in stocking rate. The production benchmark for stocking rate was based on Saul and Kearney (2002) who estimated potential carrying capacity from length of the growing season, Olsen phosphorus levels and paddock size. The scope to increase profitability was calculated from the difference between current stocking rate and the potential stocking rate, and the estimated gross margin per DSE for the target flock.

The increase in gross margin per hectare was reduced as stocking rate approached the optimum (Figure 47). This was to reflect the increase in grain feeding and the reduction in production per head with higher stocking rates. The reduction was based on a quadratic relationship and two options are presented in the tool and can be selected and calibrated by the model administrator. The default option is set such that the diminishing returns begin at 65% of the optimum stocking rate. The increase in gross margin from that level up to the optimum stocking rate is reduced by 35% (Figure 47).

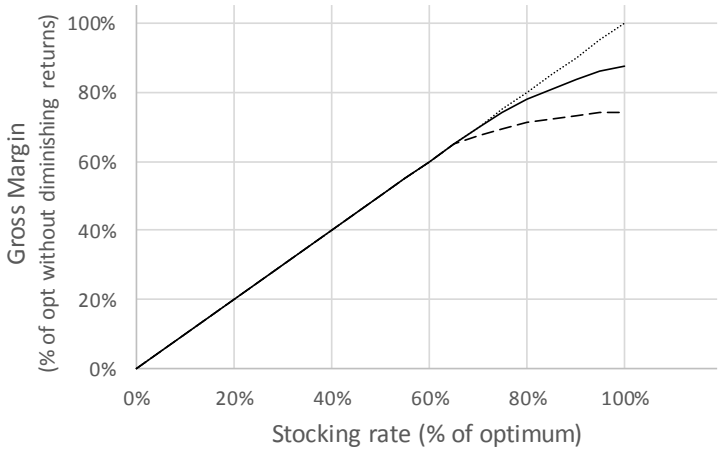

Figure 47: Representation of diminishing returns for increasing stocking rate. Solid line is the selected option, long dash is the alternative option, dotted is without diminishing returns.

4.2 Example operation

The inputs required to operate the spreadsheet are outlined in Table 17 and Table 18. Table 17 are inputs for a typical Maternal flock in SW Victoria currently achieving industry average production levels, whereas Table 18 is for a typical Merino flock in the Great Southern region of WA currently achieving industry average production levels.

Table 17: Example inputs used to operate the decision support tool. Example flock is a maternal flock in SW Victoria starting at the industry average scanning and lamb survival levels.

The growing season		Input levels	
Date of break	date	20-Mar	
Date of senescence	date	1-Dec	
Flock management & Genotype			
Breed	merino/maternal	Maternal	
ASBV for NLW	%	0%	
Area of pasture	ha	1000	
Flock size	# of ewes	5000	
Adult TOL	month	1-Jun	
Sale age of young ewes	lamb/hogget	Lambs	
Sale age of CFA ewes	years	6.5	
Olsen P levels	mg/kg	10	
Paddocks less than 20ha	TRUE/FALSE	FALSE	
Price outlook			
Lamb Price	$/kg	$5.00	
Wool Price	$/kg clean	$8.00	

Current Production Levels			
Stocking Rate	DSE/ha	17	
Reproduction		Mature	Maiden
	Scanning %	155%	140%
	Single survival	88%	83%
	Twin survival	68%	62%
	Triplet survival	50%	45%
Sheep death rates	Mature ewes	4%	
	2yo ewes	4%	
	Hoggets	4%	
	Weaners	4%	

Table 18: Example inputs used to operate the decision support tool. Example flock is a Merino flock in the Great Southern region of WA starting at the industry average scanning and lamb survival levels.

The growing season		Input levels	
Date of break	date	1-May	
Date of senescence	date	1-Nov	
Flock management & Genotype			
Breed	merino/maternal	Merino	
ASBV for NLW	%	0%	
Area of pasture	ha	1500	
Flock size	# of ewes	5000	
Adult TOL	month	22-Jul	
Sale age of young ewes	lambs/hoggets	Hoggets	
Sale age of CFA ewes	years	5.5	
Olsen P levels	mg/kg	10	
Paddocks less than 20ha	TRUE/FALSE	FALSE	
Price outlook			
Lamb Price	$/kg	$5.00	
Wool Price	$/kg clean	$12.00	

Current Production Levels			
Stocking Rate	DSE/ha	10	
Reproduction		Mature	Maiden
	Scanning %	125%	105%
	Single survival	83%	75%
	Twin survival	57%	50%
	Triplet survival	35%	30%
Sheep death rates	mature ewes	5%	
	2 year ewes	5%	
	Hoggets	4%	
	Weaners	5%	

4.3 Management priority

The output of the spreadsheet is presented as both a text description of the position of mating ewe lambs in the priority of the farm (Table 19 and 20) and a graphical representation of the results (Figure 48 and 49).

Table 19: Text description of the decision support tool results. Example results for the typical Maternal flock.

Mating ewe lambs is priority 3 of 4 in your livestock enterprise	
Priority 1	is NLW of Mature ewes with a value per farm of $129,000
Priority 2	is Pasture production/utilisation with a value per farm of $59,000
Priority 3	is Mate Ewe lambs with a value per farm of $51,000
Priority 4	is NLW of 2 year old ewes with a value per farm of $17,000

Table 20: Text description of the decision support tool results. Example results for the typical Merino flock.

Mating ewe lambs is priority 4 of 4 in your livestock enterprise	
Priority 1	is NLW Mature ewes with a value per farm of $71,000
Priority 2	is Pasture production/utilisation with a value per farm of $32,000
Priority 3	is NLW 2yr ewes with a value per farm of $22,000
Priority 4	is Mate Ewe lambs with a value per farm of -$24,000

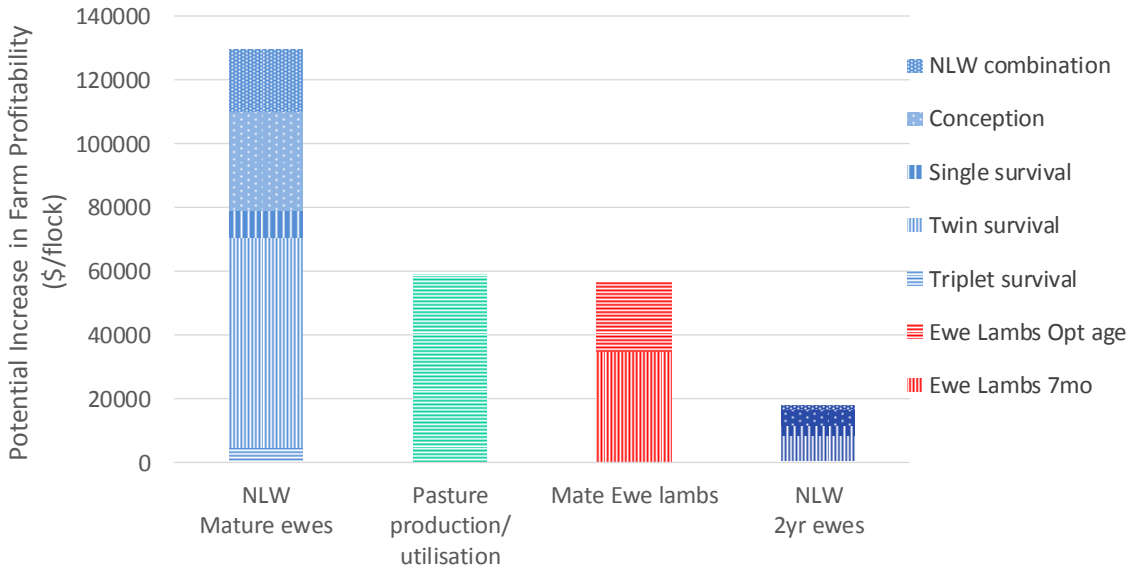

Figure 48: Graphical representation of the priority of the alternative production strategies for the Maternal flock in South West Victoria..

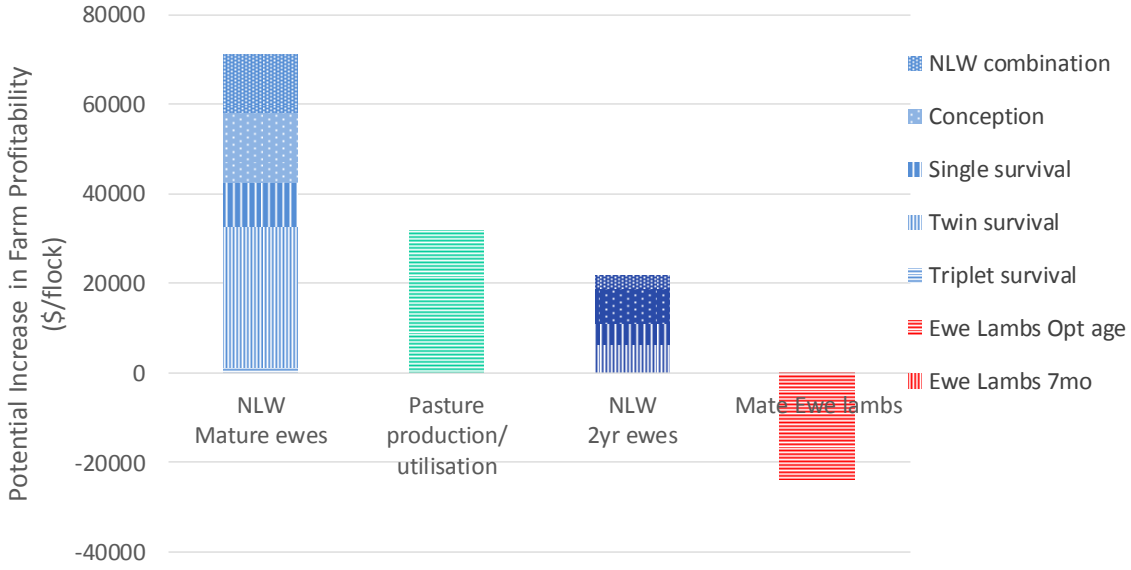

Figure 49: Graphical representation of the priority of the alternative production strategies for the Merino flock in the Great Southern region of WA..

4.4 Management if mating ewe lambs

The optimal management of the flock if mating ewe lambs is presented together with the impact on profitability of non-optimal management is followed (Table 21 and 22). The components of management covered includes:

1. Age of the ewe lambs at joining
2. LW at joining as a proportion of standard reference weight (SRW)
3. The expected number of lambs weaned (%)
4. The proportion of the ewes to mate
5. The target rate of liveweight gain during joining
6. Selling or retaining lambs scanned dry
7. The amount of extra supplement required (kg/DSE)
8. The change in the number of mature ewes (%)

Table 21: Optimal management when mating ewe lambs and the impact on profitability if following non-optimal management. The increase in profit if following optimal management is $56,300 per annum.

	Optimum Management	Management variation	Change in profit
Age at Joining	8 months	-1.0 months	-$16,700
LW at joining	73% of SRW	-10% of SRW	-$12,900
NLW	57%	-10%	-$9,500
Proportion mated	100%	-25%	-$7,900
LWC during joining	100 g/head/d	-50 g/head/d	-$5,800
Sell dry ewe lambs	Yes	Yes	-$5,300
Extra supplement	+0.7 kg/DSE		
Mature ewe numbers	-2.4%		

Table 22: Merino flock: Optimal management when mating ewe lambs and the impact on profitability if following non-optimal management. Even if following optimal management mating ewe lambs reduces profit by $24,100 per annum.

	Optimum Management	Management variation	Change in profit
Sell dry ewe lambs	No	Yes	-$20,300
Proportion mated	50%	-25%	$14,900
NLW	0%	10%	$4,300
LWC during joining	100 g/hd/d	-50 g/hd/d	-$1,100
LW at joining	65% of SRW	-10% of SRW	-$800
Age at Joining	7.0 mths	0.0 mths	$0
Extra supplement	2.6 kg/DSE		
Mature ewe numbers	-3.1%		

4.5 Steps for operation of decision tool

4.5.1 Opening and macros

When the spreadsheet is first opened it will commence with the Home screen. The spreadsheet will operate without macros being enabled but without the macros the following functionality will not be available:

a. Restoring and setting default values for the inputs
b. Setting the 'zoom' customised for your screen
c. Using an index to navigate between tables in the workbook.

These custom macros are available from the "Add-ins" ribbon ("Add-ins" menu in alder versions of Excel). The Home screen includes some instructions if you want to enable macros.

4.5.2 Set up the zoom

The 'zoom' scale can be set the first time the workbook is opened on a new computer. This is to set the width of the worksheets to fit the size of your screen. Steps:

a. Run the custom macro "Format View Scale" in the Format/Filter menu.
b. Specify the number of columns that are visible on the screen and press Enter.

The macro will scale each sheet to display across the width of your screen. If you wish to see more rows in each table then re-run the macro and enter a smaller number.

4.5.3 Data input

The data to operate the decision tool is entered in the ***Inputs*** worksheet. The worksheet is protected so that values can only be typed into the unlocked cells. Unlocked cells are coloured green.

The 'Scenario number' input is described below in section 4.5.6.

Enter data into each input cell. There are restrictions on the values that can be entered in each cell to ensure that the values are within expected ranges:

a. The date of the break and the date of senescence are used to calculate the length of the growing season. This is used in the calculation of the potential pasture production and potential pasture utilisation.
b. The breed type (Merino or Maternal) determines:
    i. the value of increasing reproductive rate
    ii. the potential scanning and lamb survival levels.
c. ASBV for NLW increases or decreases the potential NLW of the ewes, both the older ewes and the ewe lambs.
d. Area of pasture and flock size are used to scale the benefits 'per ewe' and 'per ha' to the whole flock.
e. The duration from the Adult time of lambing and the date of senescence determines whether the mating of ewe lambs can be delayed (to increase the reproductive performance achieved).

f. Sale age of ewe lambs and CFA ewes are to allow calculation of the number of ewe lambs that could be joined and the number of 2 year old ewes in the flock.
g. Olsen P levels and paddock size are included in the calculation of the potential pasture production and potential pasture utilisation.
h. The outlook prices for lamb and wool affect the value of increasing reproduction or stocking rate.
i. Current stocking rate and reproduction levels allow calculation of the potential increase in production that can be achieved on the farm. There is a test on the stocking rate input value to ensure that the number of ewes and the area of pasture is consistent with the stocking rate selected.
j. Current death rates of different classes of stock are part of the calculation of the current flock structure

4.5.4 View results

The results are presented in the *Results* worksheet. This worksheet includes four sections:

a. Summary of the inputs entered
b. A list of the production strategies evaluated in priority order including the potential increase in profitability.
c. A graphical representation of the increase in profit from achieving the potential production levels for each strategy. The reproduction strategies are divided into the components of reproduction (scanning rate and lamb survival) so that the priority areas can be visualised.
   For ewe lambs the increase in profit is reported for mating the ewe lambs at 7 months of age and with a delayed joining if this is feasible given the length of the growing season and the mating date of the adult ewes.
d. A table with the optimal management of the ewe lambs being mated and the impact on profit if non-optimal management is followed.

4.5.5 View other tables

There are two other sections to the decision support tool. Which are stored in tables in other worksheets of the workbook. These worksheets can be selected and the tables viewed. When the worksheets are first selected the tables are collapsed in an outline view. The contents can be viewed by clicking on the + sign in the left margin adjacent to the table heading. After the table is viewed it can remain expanded or be collapsed by clicking the – sign in the left margin.

a. *Database*: A database of values used to derive the potential profitability. Changes can be made to the parameters in this worksheet, however, the values can be returned to the standard values by using the 'Restore Defaults' macro as described below in section.The information is stored in four tables:
   i. Potential Reproduction levels: these values are from a report by Trompf *et al.* (2018). The report estimated the scanning percentage and lamb survival of the average flock in Australia based information from industry statistics and anecdotal evidence from scanning contractors. The potential levels that could be achieved were also estimated based on observation of levels that top farmers are currently achieving. An achievable level for industry was based on achieving 75% of the industry potential that was identified.

ii. Value of an extra Lamb: these values are from a published paper (Young *et al.* 2014) of a MIDAS analysis carried out to value extra lambs in a range of scenarios.
iii. Value of mating ewe lambs in different scenarios: These values are based on unpublished data of a MIDAS analysis carried out examining the value of mating ewe lambs in a range of scenarios. A multiple linear regression is then fitted to the data to generate a coefficient of the impact of different management and environmental influences on the value of mating ewe lambs.
iv. Other parameters used in the spreadsheet. This sheet includes parameters for equations used in the calculations.

b. *Calculations*: The calculations done to convert the input data and database information into profitability. Changes cannot be made because the worksheet is protected to ensure that errors are not accidentally introduced, however, the formulas can be viewed. The calculations are carried out in six tables:
   i. Number of lambs for mature and 2 year old ewes. Calculate the number of lambs weaned for the current flock and if achieving the potential.
   ii. Flock structure of the ewe flock. Calculate the number of ewes of different age groups which can be used to scale the profit increase per ewe
   iii. Value of achieving the potential reproduction. Value per head and value per flock if reproduction of 2 year old ewes and mature ewes is improved.
   iv. Value of achieving the potential pasture production & utilisation. Calculation of the potential stocking rate and the gap to current and the increase in profitability if stocking is increased.
   v. Value of mating ewe lambs. Calculate the increase in profit if ewe lambs are mated on the target farm.
   vi. Total value of each technology. Collates information from tables 3, 4 and 5 and manipulate to a form that can be graphed.

4.5.6 Restore and set default values

The workbook can store four sets of default values in the *Gloss* sheet which can be retrieved using macros. In its original format the workbook has default values for Merino and Maternal flocks in SW Victoria and the Great Southern of WA. These default values are based on the flocks achieving current industry average reproduction levels.

If changes have been made to the input cells and it is desired to retrieve the default values then

a. Select an input cell in the *Input* sheet or the *Database* sheet
b. Run the custom macro “Restore this table” in the Restore Defaults menu

Individual cells can also be restored or viewed if only some of the defaults values are required.

If changes have been made to the input cells and it is desired to save these as the default values then

a. Select an input cell in the *Input* sheet or the *Database* sheet
b. Run the custom macro “Set this table” in the Set Defaults menu

Similarly to Restore, Individual cells can also be set if required.

5. Key messages - Improving the reproductive performance of ewe lambs

Key messages relating to the reproductive performance of Merino and Maternal ewes lambs have been consolidated below for subsequent incorporation into MLA Tips and Tool, BWFW and Profitable Grazing Systems as appropriate. A review of BWFW was also undertaken in January 2018 and BWFW material can be modified once feedback on suggestions is provided by MLA and developers of BWFW. These draft messages will be further refined over the next 2-3 months based on testing of the DST '*Fitting mating ewe lambs into the production priorities*' under a broad range of scenarios. This will ultimately enable the key messages regarding management of ewe lambs to be ranked from high to low importance – ie critical control points.

5.1 Mating ewe lambs in context of the whole farm

1. Whole farm decision making is complex as many factors influence the profitability of sheep production systems. Other influences such as skills and attitudes also affect the behaviour of individual farmers.

2. The management and production factors that will provide the greatest return on effort for individual farmers will depend on the potential economic gain per unit change in the target factor, their current management and production levels and the ease with which the management change to increase production can be achieved in the farming system.

3. To decide whether mating ewe lambs is a priority for a specific farm it is important to consider whether there are other production issues that are likely to have a higher pay-off including: (i) improving reproduction from mature ewes; (ii) Improving reproduction from hogget ewes; and or (iii) Improving pasture production and utilisation.

4. For most farms improving reproduction of adult ewes and pasture utilisation will be a higher priority than mating ewe lambs. When farmers have optimised these factors, and are managing a genotype in a system that is delivering greater than 100% weaning for adult ewes, then mating ewe lambs should be considered in some environments.

5. A base set of skills are necessary to successfully mate ewe ewes. Farmers considering joining ewe lambs should already: (i) monitor condition score of older ewes; (ii) manage older ewes to LTEM guidelines and achieving targets; and (iii) Pregnancy scan older ewes for multiples and differentially managing twins.

5.2 Profitability of mating ewe lambs

1. Mating ewe lambs can be profitable. The profitability of mating ewe lambs depends on environment/length of growing season, ewe breed and genetic potential for reproduction, time of lambing, age of the ewe lamb at mating, age when surplus young ewes are sold,

liveweight at joining as a proportion of the SRW of the breed, liveweight change during the ewe lamb joining period, proportion of ewe lambs mated, management of the dry ewe lambs and meat price.

2. The profitability of mating ewe lambs is 2 to 3 fold greater in a high rainfall long growing season environment compared to a moderate rainfall environment. The longer growing season reduces the cost of raising the extra progeny from ewe lambs particular from weaning to sale.

3. Mating ewe lambs has little or no impact on farm profitability in the low rainfall wheatbelt region. Mating ewe lambs in the wheatbelt region is not a priority as the supply of crop stubbles through summer and autumn does not offset the impacts of the short growing season. Furthermore, the smaller flock sizes in this region do not justify the skilling up that would be required to implement the system.

4. Profits from mating ewe lambs in the moderate to high rainfall regions are typically 2 to 3 fold greater for Maternal ewe lambs than Merino ewes lambs. This is related to the higher reproduction achieved by the maternal ewe lambs, the higher value of extra lambs born and the reduction in the cost associated with reduced wool growth.

5. Mating Merino ewe lambs was slightly more profitable in an autumn lambing system than in a spring lambing system due to the extra feed that is available for the ewe lamb to gain weight prior to joining and to finish the progeny from the ewe lambs.

6. The profitability of joining ewe lambs in the moderate and high rainfall regions is highly sensitive to sheep meat price. An increase in price of $1 per kg carcass weight can increase farm profitability due to joining ewe lambs by an additional $20,000 to $35,000 ($7 to $19/ewe lamb mated).

7. Genetic potential for reproduction influences the profitability of joining Merino and Maternal ewe lambs by $2 to $7/ewe lamb for a 10% increase in NLW. Selecting sires with higher ASBVs for NLW will increase the financial returns from joining ewe lambs.

8. Joining Merino and Maternal ewe lambs at 8 months of age is much more profitable than joining at 7 months of age. The increase in NLW associated with the ewe lambs being more sexually mature outweighs the cost associated with later born progeny being more expensive to finish or there being less time for the yearling ewe to recover between weaning and hogget joining at 19 months of age.

9. There is no incentive to target just a proportion of the Maternal ewe lambs at weaning or only select a proportion of the ewes at joining. It is most profitable to mate all the ewe lambs regardless of their liveweight. The higher liveweight achieved at joining and the asymptotic relationship between liveweight at joining and NLW means that there is little increase in NLW from only mating the heavier ewe lambs.

10. It is more profitable to mate all Merino ewe lambs retained as replacements, however the marginal return from joining more than 50% is low and therefore not mating a proportion of the ewe lambs maybe a practical solution for farmers to reduce costs.

11. The economic optimum liveweight at joining varied from 60 to 80% of their mature weight for Merinos but was consistently between 72 and 75% of mature weight (42 to 45 kg) for Maternal ewe lambs. Extra liveweight gain for Maternals especially above 75% reduced profitability as this must be achieved by supplementary feeding and results in minimal if any increase in NLW.

12. Only for spring born flocks in SW Victoria was it profitable to provide supplementary feed between weaning and joining to the ewe lambs to be mated. For other scenarios iot was more profitable to feed the ewe lambs like they would normally be fed and what gets pregnant gets pregnant.

13. Feeding ewe lambs to gain at least 100 g/day during joining was always $2 to $5 per ewe lamb more profitable than feeding to allow maintenance of liveweight.

14. Always more profitable to sell dry Maternal ewe lambs after pregnancy scanning whereas normally more profitable to retain dry Merino ewes especially where pregnancy scanning occurs after the break of season. The main difference between ewe types relates to the value of the wool produced by the dry animals.

15. A target hogget liveweight of about 85 to 90% of mature weight for Merinos and 95 to 100% for Maternals would appear reasonably robust. In general it was more profitable to preferentially allocate paddock feed to ewe lambs prior to joining than yearling ewes after weaning.

5.3 Production responses of ewe lambs

1. Liveweight at the start of joining was a major determinant of the reproductive success of ewe lambs joined at 7 to 9 months of age.
    a. Reproductive rate and weaning rate of Merino ewe lambs increased linearly in response to increasing liveweight at joining and there was no evidence of a threshold response for either trait at least up to 50 kg.
    b. Reproductive rate and weaning rate of Merino ewe lambs increased by 3.4% and 2.6% per extra kg of liveweight at joining and the responses were not influenced by the ewe lambs own birth or rear type or their age at joining.
    c. Reproductive rate and weaning rate responses of Maternal ewe lambs were curvilinear and there was a significant effect of their own birth type and age at joining.
    d. When Maternal Composite ewe lambs achieved 45 kg at joining their reproductive rate and weaning were within 2 to 3% of their maximum.
    e. On average, at the same joining liveweight the reproductive rate and weaning rate of triple born Maternal Composite lambs was about 17% and 11% greater than twin born lambs which were in turn 14% and 7% better than that achieved by single born lambs.

f. The age effects of the reproductive rate and weaning rate of Maternal ewe lambs was quadratic. The difference in reproductive rate between lambs joined at 6.5 *vs*. 7.5 months of age was 38% whereas only 6% between those joined at 7.5 *vs*. 8.5 months of age.

2. Improving the nutrition of Merino ewe lambs during joining significantly increases their reproductive rate, and the effects of liveweight at joining and growth rate during joining are additive.
   a. For every 100 g/day increase in growth rate during joining the reproductive rate in Merino ewe lambs increased by 20%, and most of the effect of growing faster during joining on reproductive rate was in addition to the fact that faster growing lambs are obviously heavier at the time of conception.
   b. Growing an extra 100 g/day during joining had a similar impact on reproductive rate as an extra 5 kg of liveweight at the start of joining.

3. Liveweight at joining and throughout pregnancy influenced the birth weight and weaning weight of their progeny, but these effects were variable across ewe types.
   a. The progeny from ewe lambs which were 10-kg heavier at joining were about 0.2 kg heavier at birth and 1.3 to 2.9 kg heavier at weaning, and these responses were similar regardless of birth type.
   b. A 10-kg gain in liveweight between Day 90 of pregnancy and lambing increased the birth weights of their single and twin born progeny by about 0.6 kg, but increasing liveweight between joining and Day 90 of pregnancy had no significant effect on birth weights.
   c. A 10-kg gain in liveweight between joining and Day 90 of pregnancy or between Day 90 of pregnancy and lambing increased the weaning weight of their progeny by 0.8 kg and 3.2 kg respectively.
   d. The effects of liveweight gain in the different periods was additive.

4. The birth weight of progeny born to Merino and Maternal ewe lambs was significantly related to their survival to weaning.
   a. The optimum birth-weight for maximum survival was between 4.5 and 6.0 kg for single and twin born lambs, but this varied between ewe-types.
   b. The average birth weight for single and twin born progeny from Merino ewe lambs was 4.7 and 3.9 kg, and for single, twin and triple born progeny from Maternal ewes was 5.0. 4.2 and 3.6 kg.
   c. The effects of liveweight profile of ewe lambs on the survival of their progeny appears to be up to 50% larger than those attributed to changes in birth weight alone, so the higher survival of progeny from well grown ewe lambs is more than likely a reflection that they also have less lambing issues and they have improved mothering ability.

5. Liveweight at the start of joining was also a determinant of the reproductive success of Merino and Maternal Composite ewes mated a second time at 19-20 months of age.
   a. The average reproductive rate of hogget ewes varied between flocks and years from 0.7 to 2.3% but if anything maybe less than the typical response observed in adult ewes of 2.0% extra foetuses scanned per kg per 100 ewes joined.

b. At the same liveweight at hogget joining, there was no significant difference in the reproductive rate or weaning rate of Merino or Maternal ewe lambs that were born as a single, twin or triple.
c. At the same liveweight at hogget joining, Maternals that were twin and triple bearing as ewe lambs had a significantly higher reproductive rate and weaning rate than those which had a single lamb or were dry when mated at 7-9 months of age.

6. Progeny from Merino and Maternal ewe lambs grow slower to weaning and produce less wool during their life.
   a. Progeny from ewe lambs were 3 to 4 kg lighter at weaning than those from hogget and adult ewes.
   b. Progeny from ewe lambs produced 0.2 to 0.4 kg less wool than those from older ewes.

7. Progeny from Merino and Maternal ewe lambs had a lower reproductive performance than those from adult ewes when bred as a ewe lamb.
   a. This was partly because the progeny born to ewe lambs were lighter at joining and one to two months younger.
   b. Progeny born to ewe lambs may be less suitable to be bred at a young age.
   c. There were no significant effects of dam age on reproductive potential of their progeny at their hogget or adult joining's in either Merino of Maternal Composites when adjusted for differences in liveweight at joining.

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