Maidens PDS Analysis

Farm Optimisation Group

Michael - June 2025

Background

Optimising the nutritional profile for sheep is a complex task, requiring whole-farm, year-round feed budgeting. This involves considering both the seasonal dynamics of feed supply—including how pasture responds to grazing pressure—and feed demand, which is closely linked to production outcomes. Because of this complexity, identifying optimal nutrition targets requires whole-farm optimisation modelling. These models rely on livestock production equations that connect genetics, feed intake, timing, etc with animal performance. Therefore, a key research priority is ensuring that these equation systems remain accurate and are updated as new scientific insights become available.

This analysis focuses specifically on improving nutrition targets for maiden ewes, based on new data linking nutrition to reproductive outcomes. Currently, modelling coefficients for maiden ewe reproduction are assumed to be the same as those for mature ewes. However, preliminary analysis suggests that maiden reproduction is less responsive to joining live weight and may be influenced by liveweight change (LWC) during joining.

The aims of this analysis are to determine:

1. The optimal live weight (LW) target for joining maiden ewes.
2. The optimal growth path from weaning through to 19 months of age.
3. The best management approach for maiden ewes during joining.
4. The potential profit increase for producers under the revised condition targets, compared to previous targets based on less accurate coefficients.

Method

Farm system

This analysis was undertaken for a “typical” farm in the Hamilton region of Southwest Victoria. The results will be specific to the modelled farm however it is expected that similar conclusions can be drawn for other systems.

Table 1: Key features of the modelled farms.

Farm size (ha)	1,000
Time of lambing	Spring lambing
Pregnancy scanning management	Scanning for multiples
Sheep liveweight	Nutrition profile is optimised by AFO
Sheep genetics	Medium frame merino
Standard reference weight (kg)	60

Adult fibre diameter (μ)	21

Model

This analysis uses the Australian Farm Optimiser (AFO), a whole-farm optimisation model that is particularly well-suited to evaluating sheep nutrition strategies within the broader context of farm operations. AFO has an unmatched level of detail in its livestock production equations, making it capable of capturing the biological and economic trade-offs associated with nutritional management. An earlier version of AFO was used to establish the ewe nutrition targets featured in the Lifetime Ewe Management (LTEM) course, which is widely adopted by producers.

AFO is a whole farm linear programming model that supersedes the popular MIDAS model. The model represents the economic and biological details of a farming system including modules for rotations, crops, pastures, sheep, crop residue, supplementary feeding, machinery, labour and finance. Furthermore, it includes land heterogeneity by considering enterprise rotations on any number of soil classes. Full details of the model can be found here: AFO documentation.

New coefficients

This project recorded maiden ewe reproductive outcomes across a range of joining live weights, condition scores, and liveweight changes during joining. To quantify these relationships, an ordinal logistic regression model was applied using the clmm() function from the ordinal R package. The response variable was the pregnancy scan result (Dry, Single, Twin), treated as an ordered categorical outcome.

Key predictors included:

- Joining liveweight (JoinWT)
- Liveweight change during joining (PostJoinGain)
- Condition score at joining (CS)

Additional variables like day of joining and latitude were not significant, likely due to limited data.

Typically, Liveweight at joining (LWj) and Standard Reference Weight (SRW) are used to reflect animal condition while avoiding correlation between liveweight and condition score. However, in this dataset, LWj and SRW were highly correlated (r = 0.96), suggesting that all animals at each site experienced similar nutritional conditions between weaning and joining. This high correlation made it difficult for the model to distinguish the individual effects of LWj, CS, and maturity. While JoinWT and CS were moderately correlated (r = 0.6), multicollinearity checks using Variance Inflation Factors (VIF) showed values below 2, indicating no serious concerns. Correlation matrices further supported the assumption of predictor independence.

The final model was selected based on both statistical performance and biological plausibility.

The model confirms that maiden reproduction responds differently to nutrition compared to adult ewes. Liveweight gain during joining had a clear positive effect, the response to joining liveweight was stronger than previously assumed (Figure 1). This supports the use of updated coefficients to better reflect maiden-specific physiology.

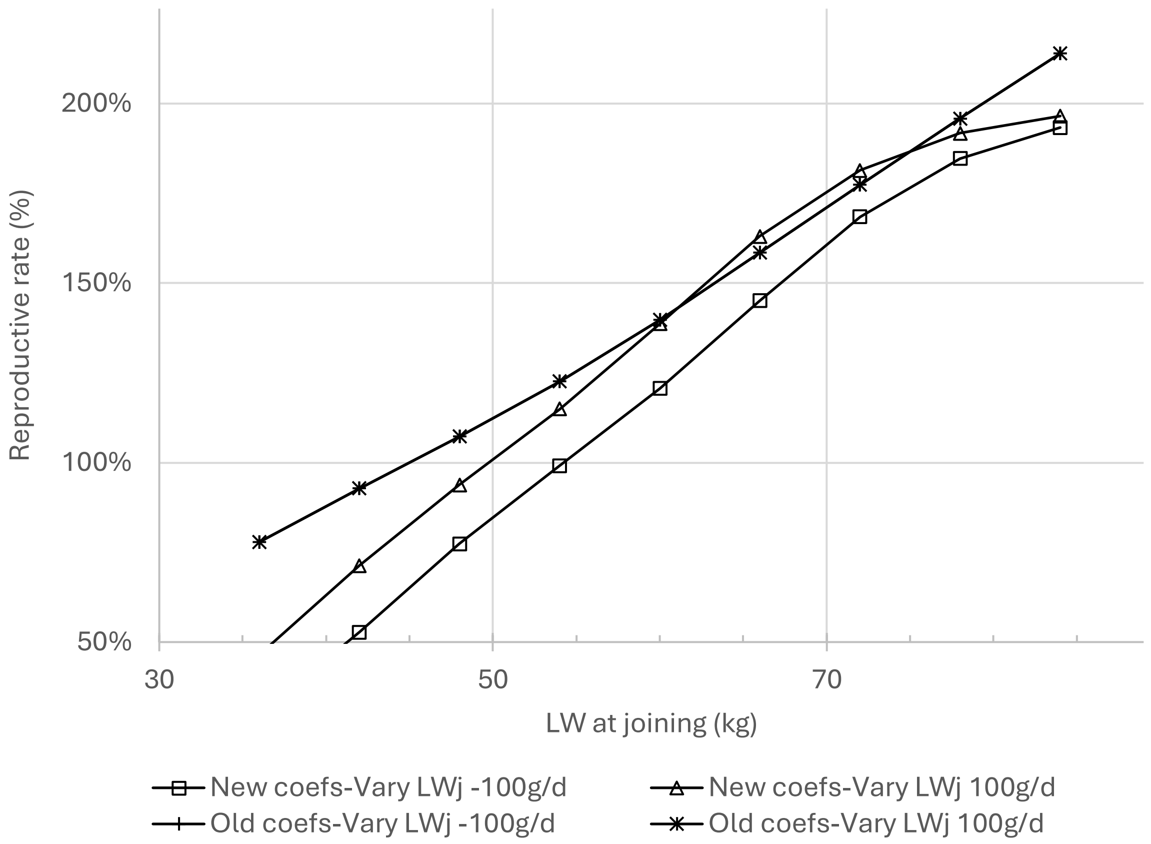


Figure 1: illustrates predicted reproductive outcomes using the new vs. old coefficients, highlighting the difference in sensitivity to joining weight and liveweight change.

Other coefficients

This project has focused specifically on updating a small subset of reproduction-related coefficients relevant to maiden ewes. The broader livestock model will continue to rely on Lifetime Wool coefficients for 2-year-old (2yo) ewes and their progeny. In most cases, these assumptions do not account for any long-term impact of being a maiden ewe. Key parameters that remain unchanged and will be drawn from existing Lifetime Wool data include:

1. The effect of liveweight change during pregnancy on lamb birth weight
2. The relationship between birth weight and lamb survival
3. The lifetime productivity of lambs born to 2yo ewes, including:
   a. Weaning weight
   b. Hogget wool production
   c. Adult wool production
4. The impact of liveweight at hogget joining on future reproductive performance, as explored in prior analyses using Pooginook data

Results

Improved maiden production equations

Applying the improved model for predicting reproductive outcomes in maiden ewes has resulted in more accurate nutritional optimisation. As a result, the target liveweight change during joining has increased significantly—now favouring weight maintenance rather than loss. While the optimal joining weight has remained similar (Figure 2). These updated targets reflect a better representation of maiden ewe biology.

The economic impact of implementing these revised targets will depend on each farm's current nutritional management. However, under a scenario where producers were previously using established best-practice guidelines—such as those recommended by the Lifetime Ewe Management project—the new targets are projected to increase whole-farm profit by 0.5%. Income per ewe would rise by $4.90 (2.1%), and weaning rates would increase by 10%. The improved reproductive performance allows for a 2.1% reduction in the number of ewes mated and 0.5% reduction in stocking rate (Table 2).

Table 2: Key implications of improved coefficients on optimal farm management and resulting profitability

Change in farm profit	Change in income per ewe	Change in weaning rate	Change in stocking rate	Change in total ewes mated
0.5%	$4.9 (2.1%)	10%	-0.5%	-2.1%

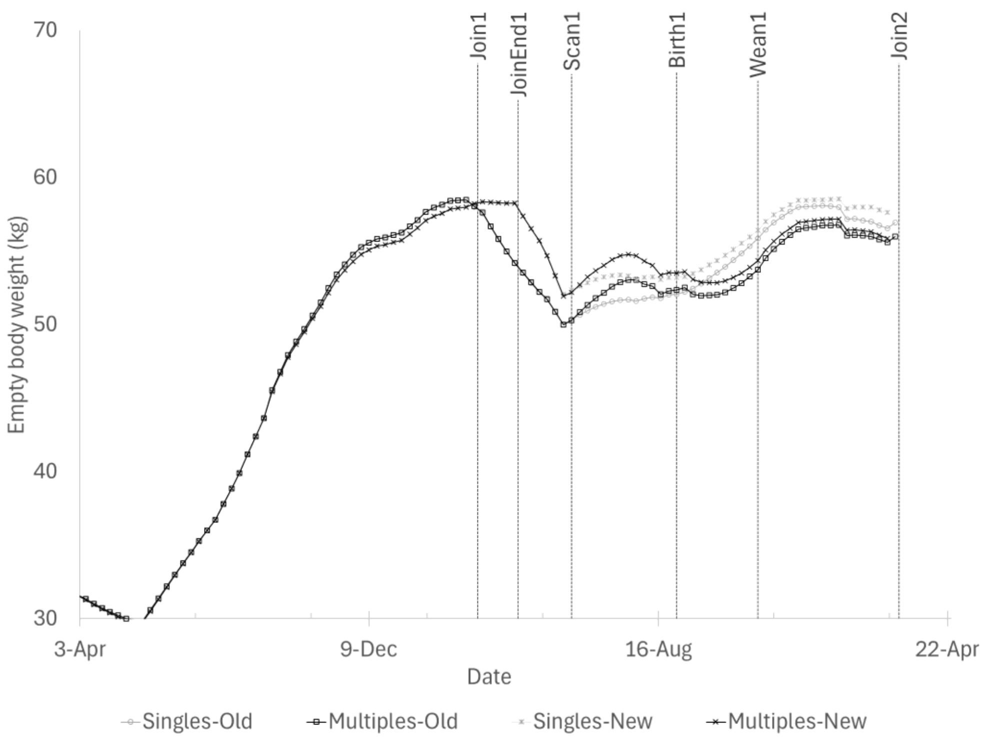


Figure 2: Optimised empty body weight profile under the old and new maiden reproduction coefficients.

Optimal maiden nutrition targets

In light of these findings, producers should consider updating their nutrition targets to align with the revised modelling, aiming for:

1. A joining weight equivalent to 96-98% of Standard Reference Weight (SRW).
2. A liveweight change during joining of 0 g/day.

Profitability is sensitive to these targets, with higher joining weights and weight maintaining during joining generally leading to greater returns (Figure 3). However, when joining weight exceeds the standard reference weight (SRW), profitability can decline sharply, due to the inefficiency of weight gain at high conditions.

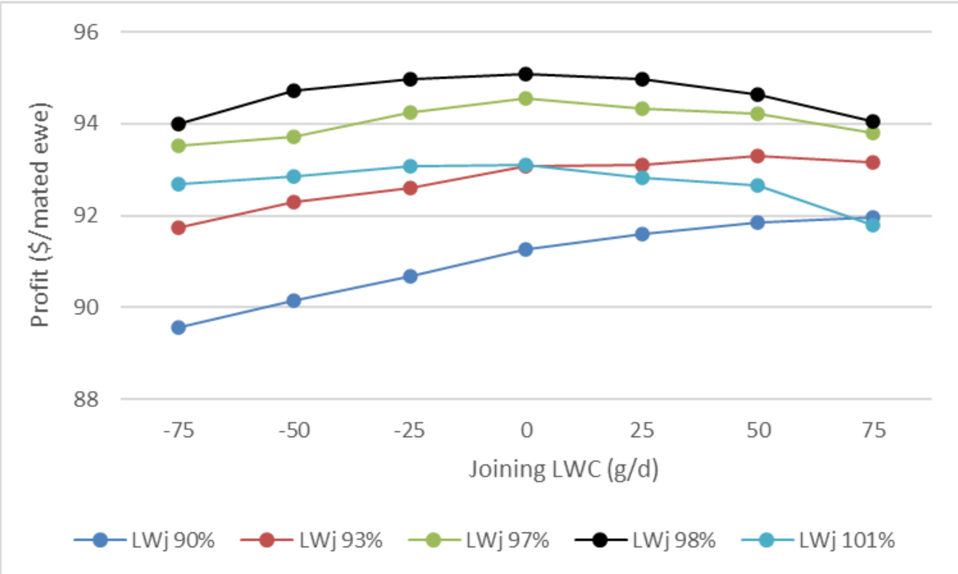


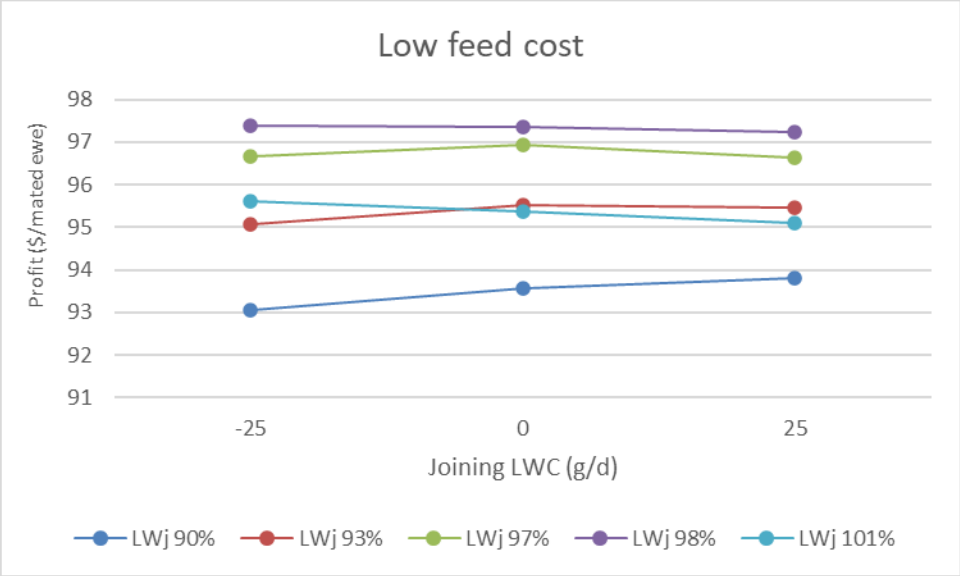
Figure 3: Effect of joining liveweight change (LWC; g/day) on profitability ($/mated ewe) across a range of maiden ewe joining weights (LWj; expressed as a percentage of standard reference weight).

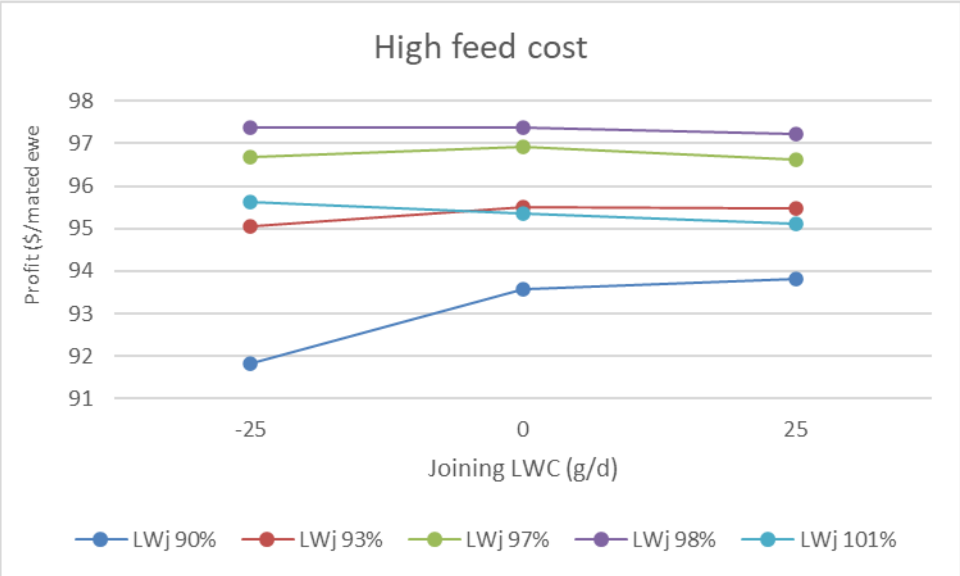
Impact of supplement cost on optimal joining weight

Changes in supplement cost (Table 3) do not significantly alter optimal nutrition targets. A more effective response to rising feed costs is to adjust the stocking rate (e.g., through destocking) and/or the amount of supplement fed. Modifying nutrition targets in response to feed cost changes can have flow-on effects that ultimately reduce profitability.

Table 3: Supplement sensitivity

	High	std	low
SA	125%	100%	75%
Price ($/t)	440	352	264
$/mj	0.033	0.026	0.020





Further work

1. If this type of trial were ever to be re-run, it would be recommended to increase variation in nutritional management among maiden ewes prior to joining. As this would allow the statistical modelled to better separate the effects of SRW, maturity, and condition.
2. The analysis above has identified optimal nutrition targets for maiden ewes based on updated relationships. However, further analysis would be valuable to assess the economic importance of achieving these targets (ie what is the cost of not achieving the target) and to determine which ones have the greatest impact. Due to time and budget constraints, this was beyond the scope of the current analysis.
3. Results (Figure 4) show that maiden ewes with higher scanning rates are more likely to maintain higher scanning rates as 2.5-year-olds, with a reduced response to condition score. This likely reflects a genetic effect—better-performing ewes remain productive even under suboptimal conditions. On-farm, this insight influences culling decisions and the nutrition strategy for the remaining flock. Specifically, it suggests that culling dry maidens may improve reproductive performance at 3 years of age while reducing the

influence of condition score. In AFO, culling maidens does increase later reproduction, but the response to joining condition remains unchanged. Evaluating the economic impact of culling on 3-year-old nutrition would require further analysis and significant AFO modifications. As culling was not a focus of this project, this line of investigation was not pursued.

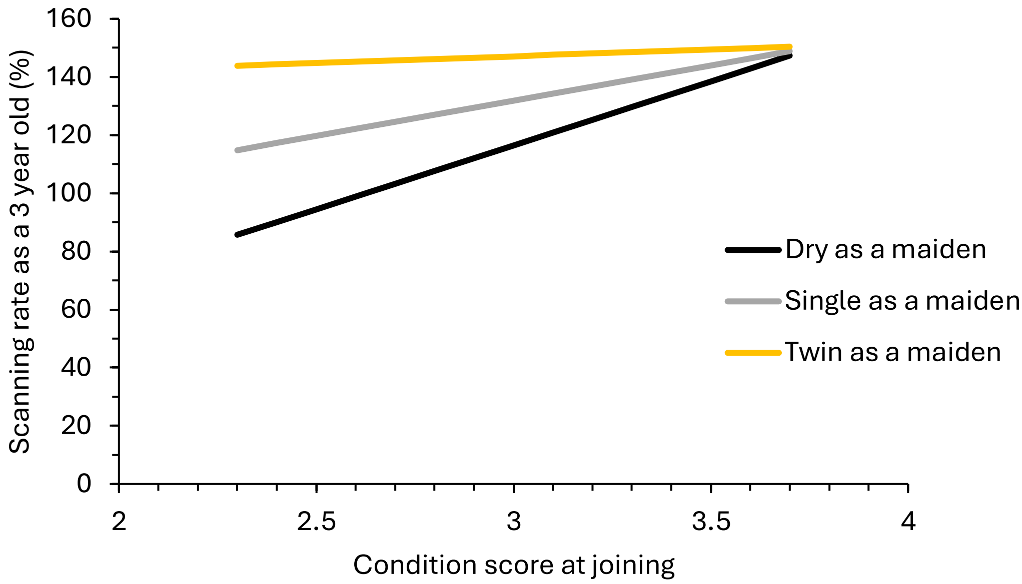


Figure 4:The effect of condition score at the second joining as a 2.5-year-old on conception rate of Merino ewes at five producer demonstration sites across Australia