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Contents

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Pregnancy scanning increases profit for all flocks and times of lambing

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Introduction

Pregnancy status, number of fetuses and fetal age can be identified by ultrasound scanning. Previous economic analyses have drawn varying conclusions about the profitability of implementing pregnancy scanning on-farm (Bowman *et al.* 1989, Holmes and Sackett 2008, McGrath *et al.* 2016 and Young *et al.* 2016). Adoption of pregnancy scanning has been slow (Howard & Beattie 2018, Curnow & Conte 2018) and the surveys indicate that the single largest reason for not adopting is that producers "see no benefit". Therefore, it was considered important to address the question of the on-farm benefit of pregnancy scanning with a comprehensive economic analysis.

Information about the pregnancy status of ewes (pregnant/not pregnant) can be used to:

- Cull the ewes that are scanned empty prior to next joining. Reproduction rate (number of fetuses per ewe) is

a repeatable trait so culling these ewes can increase reproduction of the remaining flock in subsequent years (Kleeman *et al.* 2016, Hatcher *et al.* 2018).
- Reduce the feed offered to the empty ewes or sell them at scanning.

The additional information from scanning for multiples allows extra management adjustments:

- Differential nutrition during pregnancy based on litter size. There are 3 drivers for the value of making this adjustment
    - Progeny survival (Oldham *et al.* 2011) and the total value of the progeny wool (Thompson *et al.* 2011) is more responsive to optimal nutrition for twin bearing ewes, hence extra feeding of the twin bearing ewes at the expense of the single bearing ewes improves flock productivity.
    - Single bearing ewes, particularly maternal breeds, if overfed during pregnancy can have birthing difficulties that leads to increased ewe and lamb mortality from dystocia.
    - Twin bearing ewes are more sensitive to under feeding in late pregnancy and can suffer from pregnancy toxemia, whereas this is only a minor problem for single bearing ewes.
- Altering allocation of lambing paddocks based on litter size as twin born lambs are more sensitive to chill than their single born counterparts.
- Incorporating information on birth type in the selection of replacement progeny for the breeding flock.

There are other benefits of pregnancy scanning that haven't been included in this analysis:

- The information from scanning can help to identify the points in the reproductive cycle where wastage is occurring, thus improving reproductive management.
- Being proactive about reducing lamb mortality because fetus number is an essential piece of information to calculate lamb survival of single and twin born lambs.
- Early detection of reproductive failure, which allows early remedial action such as remating or if the failure is due to a disease outbreak, providing earlier response for disease control.

Aims

To address the survey finding that a majority of farmers who currently don't use pregnancy scanning do so because they "see no benefit". We carried out a comprehensive evaluation of the profitability of utilising the information provided by pregnancy scanning for pregnancy status and for multiples for a range of regions, genotypes and times of lambing. We test the hypothesis that pregnancy scanning can increase farm profitability.

Methods

A wholefarm bio-economic model called the Australian Farm Optimisation model (AFO) was used to assess the profitability of management changes that can be implemented based on information provided by pregnancy scanning. AFO is a new and improved version of the MIDAS model. MIDAS has been used extensively in Western Australia to assess profitability of on-farm management decisions (e.g. Young *et al.* 2022).

AFO is an appropriate model to carry out this analysis because it incorporates both the biological and economic implications of altering livestock management. It includes a detailed feed budget that matches the feed requirement of animals throughout the year with the feed available from pasture, stubble or grain supplement. This allows optimisation of the nutrition profile of different classes of sheep while accounting for the change in production and the impact on stocking rate and supplement required.

The analysis was carried out for three regions with varying length growing seasons: a long growing season based on south-west Victoria; a medium growing season based on the Darkan area in the Great Southern of WA; and the short growing season based on the central wheat

belt of WA. For each region, three lambing times (autumn, winter, spring) and three breed types (Table 1) were evaluated.

Table 1 A description of the flock types included in this analysis

Flock	Description
Merino	A self-replacing Merino flock with emphasis on wool production. Wethers sold as either store lambs to other farmers (6 months) or as shippers (18 months).
Mer-TS	A self-replacing Merino flock utilising surplus ewes (cast for age or surplus ewe hoggets) for first-cross lamb production sold as suckers (4.5 months). Merino wethers can be sold as Merino prime lamb or as shippers. The emphasis is on meat and wool production.
Maternal	Composite ewes are mated to composite rams to produce composite lambs. Wethers sold as prime lambs (4-5 months), and the emphasis is on meat production.

The cost of scanning represented in the analysis included both the cost of the contractor and the labour cost associated with pushing the ewes through the scanning crate and the mustering that is required per mob (Table 2). If all labour was provided by casual labour, the labour cost varied between $0.31/ewe if scanning pregnancy status only. This increased up to $0.40/ewe when scanning for multiples.

The cost of casual labour was $256 per day ($32/hr all-inclusive for an 8-hour day). To reflect the competition for labour between the livestock and crop enterprises at seeding, the amount of casual labour that was hired depended on the timing of scanning relative to seeding.

Table 2 The assumptions used for the cost of contracting. Source of contract cost: Cousins Merino Services with more than 2000 ewes to scan.

	Wet/Dry	Multiples
The contractor		
Contract cost ($/hd)	$0.50	$0.75
Travel ($/hd)	$0.02	$0.02
Throughput (hd/day)	3000	2000
Farmer provided labour		
Yard work – labour units	2	2
Cost per hd*	$0.17	$0.26
Mustering*	$0.06	$0.06
Other costs		
R&M on infrastructure and fuel	$0.08	$0.08
Total cost	$0.83	$1.17

* assuming that all labour is hired

The value of scanning was calculated by comparing farm profit if the flock was not scanned with a flock that was scanned. The comparison was carried out for flocks that were scanned for multiples or only scanned for pregnancy status. If the ewes were not scanned for pregnancy status, then all ewes of each age group had the same nutrition profile during pregnancy and lactation, and lamb mortality was estimated using a common chill index across all ewes. If ewes were scanned for pregnancy status, then the nutrition profile of the dry ewes was optimised separately to the pregnant ewes for the period from scanning through to the next joining. Also, the sale time of the dry ewes was optimised including options to sell the dry ewes at scanning or at the following shearing.

If the ewes were scanned to also identify multiples, then the nutrition profile of the single and multiple bearing ewes could be separately optimised. Twin bearing ewes were allocated to the better lambing paddocks and the single bearing ewes were allocated to the more exposed

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paddocks. The proportion of single and twin born progeny selected as replacements was adjusted to account for the expected difference in lifetime wool value and lifetime reproduction.

An allowance was made in this analysis for some discrepancy between the scanning results and the lambing outcome. Bunter (2020) showed an agreement between scanning results and mothering up results averaged 86% in the Sheep Genetics database including 68 360 records. In this economic analysis, allowance was made for all the discrepancy to be associated with scanning errors. This is a very conservative assumption with respect to estimating the value of scanning because Bunter (2020) observed that some of the errors would be due to assigning litter size at lambing and concluded this was the most likely source of discrepancy.

Sensitivity analysis was carried out to examine the impact of the proportion of 'empties' and 'multiples' in the flock; the average chill factor at lambing; the increase in reproductive rate expected from culling the passengers; and price of wool, meat and grain.

The differences in production and the responses to altering nutrition of the single and multiple bearing ewes was based on a synthesis of information from the Lifetime Wool research carried out in Western Australia and south west Victoria (Oldham *et al.* 2011, Thompson *et al.* 2011) and the CSIRO GrazPlan models (Freer *et al.* 2012).

Results and discussion

Value of scanning

Utilising the information from pregnancy scanning for multiples increased profitability for all 27 scenarios of region by genotype by time of lambing (Table 3). The average profit was $5.75 per ewe scanned and ranged from $1.20 up to $10.60 per ewe. This equated to a 400% return on the scanning investment. These results and the other benefits that have not been included in this analysis indicate that pregnancy scanning is likely to increase profitability for the majority of farmers.

The value of scanning was higher for flocks that were lambing in autumn and slightly less for flock lambing in spring. This difference in value associated with time of lambing is because the early lambing flocks are scanning and identifying the empty ewes prior to the main feed shortage, which increases the value of adjusting their nutritional management or from selling at scanning.

Table 3 The increase in farm profit from scanning for multiples and implementing optimum management ($/ewe scanned) for each of the 3 regions and 3 flock types for 3 times of lambing

Region & Flock		Time of Lambing		
		Autumn ($/ewe)	Winter ($/ewe)	Spring ($/ewe)
Long Growing Season	Merino	7.20	10.60	3.80
	Mer-TS	6.40	8.80	6.00
	Maternal	7.50	8.80	5.40
Medium growing season	Merino	7.80	2.80	5.50
	Mer-TS	9.80	5.20	3.70
	Maternal	5.80	4.00	4.20
Short growing season	Merino	4.60	4.60	1.20
	Mer-TS	5.20	4.70	1.90
	Maternal	8.40	3.50	6.50
Average		7.00	6.10	4.25
Overall average		5.75	Return on investment: 400%	

Management changes required to capture the benefits of scanning

In order to capture the potential benefits of scanning, it is necessary to implement management changes for the ewes scanned with different pregnancy status and litter size. Each of the management changes are associated with capturing a portion of the potential profit

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(Table 4). The contribution of each management component varied across the scenarios. On average about half the total value could be captured if the ewes were scanned only for pregnancy status and it was necessary to scan for multiples to capture the full benefits.

The biggest single contributor to profitability of scanning for multiples was selling the passengers to increase subsequent reproduction in the flock (Table 4). The other management components each made a similar contribution to the total value of scanning.

The comparison between selling 'once dry' or 'twice dry' ewes showed that selling 'once-dry' was more profitable for the flocks that can maintain flock size with this higher level of culling. This should be achievable for flocks that have a weaning percentage greater than 90%. For flocks with a lower weaning percentage, selling 'twice-dry' was best. The best time to sell is a trade-off between the feed that can be re-directed as a result of selling the empty ewes early vs the wool production that is foregone by having fewer animals during the spring flush. For maternal flocks and Merino flocks that are scanning prior to the main feed shortage, selling at scanning is usually most profitable.

Table 4 The contribution of each management component to the value of scanning and whether that component is possible based on the level of scanning undertaken

	Multiples	Pregnancy status	Value ($/ewe)
Sell the passengers	✓	✓	1.75
Feed allocation			
to pregnant ewes	✓	✓	1.00
to multiples	✓	×	1.00
Paddock allocation	✓	×	1.00
Replacement selection	✓	×	1.00

Capturing the benefit of altering feed allocation requires adjusting the condition score targets for empty, single-bearing and twin-bearing ewes. If the ewes are not scanned, then at lambing the empty ewes will typically be 0.5 CS higher than the single bearing ewes, and the twin bearing ewes will be 0.5 CS lower. If the ewes are scanned for litter size, the optimum profile is to have the empty ewes that are retained 0.5 to 1.0 CS lower than the single bearing ewes and the twin bearing ewes 0.3 to 0.5 CS higher at the point of lambing. At weaning, the target is to have the empty ewes with a CS similar to the twin bearing ewes, which will be similar or slightly less than the single bearing ewes.

To capture the potential benefit associated with paddock allocation requires identifying the better lambing paddocks and allocating the twin bearing ewes to these paddocks and the single bearing ewes to the poorer, more exposed paddocks. During lactation the twin bearing ewes have higher energy demand, so managing these paddocks to achieve a higher FOO at lambing is also beneficial.

To capture the benefit of adjusting the selection of the replacement ewes requires identifying the progeny as either single or twin born and being able to separate on birth type when the replacement ewes are being selected. The optimum proportion of singles and twins to select was not quantified in this study, but it has been observed on farm that if the twin born progeny have not been identified they will be selected against because they are smaller than their single born counterparts. It is expected that biasing the selection towards the twin born progeny will improve long term profitability, especially for flocks that have more focus on meat production than wool production.

Prices

Changing wool prices and grain prices across the range of price scenarios examined had little effect on the value of scanning (Figure 1). This is because adopting scanning has little effect on the total quantity of wool produced, and the adoption of scanning and the change in ewe

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nutrition profiles does not have a consistent effect on the total quantity of supplement fed. In contrast, varying the meat price did alter the value of scanning (Figure 1) because the quantity of lamb produced is increased. Altering the meat price scenario down to the 50th percentile ($4.65/kg DW for lamb) and up to the 90th percentile ($6.70/kg DW) altered the value of scanning by plus or minus 30% on average. The range of lamb price that is associated with the percentile change is plus and minus 18%, so the value of scanning changes by a greater proportion than the lamb price.

Extrapolating the results of this analysis would indicate that lamb price would have to drop by 60% to $2.50/kg for the average profitability of scanning to drop to zero. So, although the profitability of scanning is sensitive to meat price, the likelihood of scanning becoming unprofitable is low.

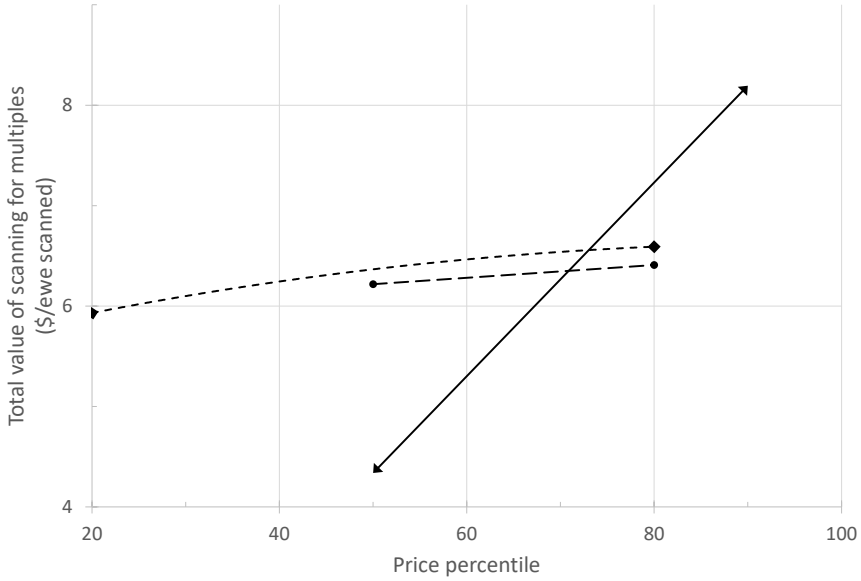

Figure 1 Impact of altering meat price (▶), wool price (l) and grain price (♦) on the value of scanning for multiples averaged across the 27 scenarios of region, flock and time of lambing

Flock reproduction rate

The reproductive rate of the flock has very little effect on the total value of scanning for multiples (Figure 2); the change in the value of scanning if the reproductive rate is below 100% to above 175% is less than $1.50 per ewe scanned. However, across this range, the benefit shifts from being predominantly associated with managing the empty ewes to being predominantly managing the multiple bearing ewes.

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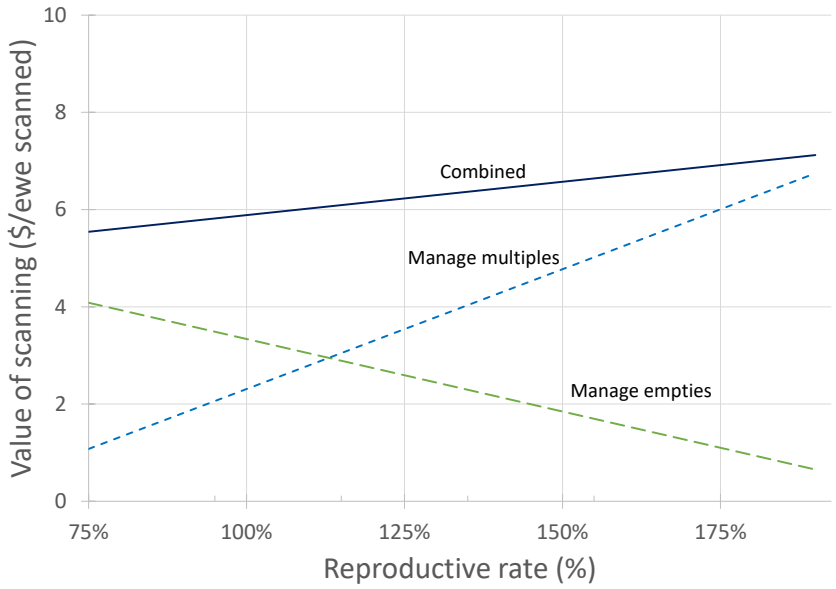

Figure 2 The value of pregnancy scanning for multiples is not sensitive to the reproductive rate of the flock, although the contribution from managing the empty ewes or managing the multiple bearing ewes changes across the range

Key messages

- Pregnancy scanning is low-cost with a high return on expenditure.
- Pregnancy scanning for multiples increased potential profit in all the scenarios examined, with an average increase of $5.75/ewe scanned.
- Scanning for multiples was twice the value of scanning for pregnancy status only.
- Capturing the potential profit requires implementing some management changes to utilise the information provided from scanning.

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The reproductive performance of maiden ewes across Australia

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Introduction

It is widely accepted that the reproductive performance of ewes in their first breeding season (maiden ewes) can be poorer and more variable than at subsequent breeding seasons. However, the extent and causes of the poorer reproductive performance of maiden ewes on Australian sheep farms are not well understood. Improving the reproductive performance of maiden (primiparous) ewes lambing for the first time at either 12 months of age (ewe lambs) or at 24 months of age (two-tooth or hogget) would have a significant effect on the efficiency of the Australian sheep flock. This is a key priority for the Australian sheep industry as we endeavour to rebuild the national flock, increase production to meet increasing consumer demands, mitigate greenhouse gas emissions and improve animal welfare. However, in order to improve the reproductive performance of maiden ewes, we must first understand where the inefficiencies are occurring.

Aims

This study aimed to determine the difference in reproductive performance between maiden and multiparous ewes across major sheep producing regions of Australia to inform strategies to improve reproductive performance in maiden ewes. We hypothesised that (i) maiden ewes joined either as ewe lambs or two-tooth ewes will have lower marking rates than multiparous ewes, and (ii) this will be due to a combination of lower reproductive rate and lower lamb survival between scanning and marking.

Methods

This study surveyed sheep producers from Western Australia, South Australia, Victoria, New South Wales and Tasmania. Sheep producers were recruited for the survey between 2019 and 2021 and completed a questionnaire focused on reproductive performance for ewes that lambed between 2018 and 2020. This included data recorded at pregnancy scanning (typically conducted 70–90 days from the start of mating period) and lamb marking (tail docking).

Respondents were selected for inclusion in the survey on the basis that:

- They separately managed maiden ewes mated as ewe lambs (7–10 months at start of mating period) or two-tooth ewes (16–22 months at start of mating period);
- Utilised pregnancy scanning by transabdominal ultrasonography to determine the number of foetuses for maiden and multiparous ewes; and
- Were able to determine lamb survival to marking for maiden and multiparous ewes on the same property, which generally required managing maiden ewes separately from multiparous ewes during lambing.

Very few responses were received for Merino ewe lambs and non-Merino maiden two-tooth ewes during the first 12 months of the study, so they were subsequently excluded from the survey, and only non-Merino ewe lambs and Merino two-tooth ewes were targeted thereafter.

The questionnaire collected details regarding the general farm characterisation, followed by 3 sections pertaining to reproductive performance: data for maiden ewes at scanning, for maiden ewes at lamb marking and for multiparous ewes at scanning and lamb marking. Sheep data were collected for each mob of maiden ewes and for the total population of multiparous ewes for each farm. Critical data included mob size at joining, age, dam and sire breed, month of joining, body condition score at joining, mob size at scanning, number of foetuses identified at scanning, and number of dry ewes. Producers were given the opportunity to volunteer

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additional information such as length of joining period, condition score at joining and lambing, predominant pasture types, feed-on offer and supplementary feeding strategies.

All statistical analyses were performed using GENSTAT (VSN International 2017, Hemel Hempstead, UK) and IBM SPSS Statistics (version 24) (IBM 2021, Armonk, NY, USA). For all analyses, main effects and interactions were only included if they were statistically significant ($p < 0.05$).

Results and discussion

To our knowledge, this is the first study to compare the marking rate of maiden and multiparous ewes and their components on commercial farms across Australia. A total of 79 respondents provided complete data for maiden and multiparous ewes and were eligible for inclusion in the study. Of these, 16 producers contributed data for two years, and three producers contributed data for three years to give a total of 103 survey responses that represented 111 117 maiden ewes managed in 307 mobs from lambing to marking. A total of 302 585 multiparous ewes were included in eligible survey responses.

The mean farm size was 3750 hectares (range: 230–115 000 hectares), and the mean number of breeding ewes per farm was 4762 (range: 477–25 000 ewes). The average age at joining of maiden ewes analysed in the Merino two-tooth category was 18.5 months. The average age at joining of maiden ewes analysed in the non-Merino two tooth category was 8 months.

The inclusion criteria generated bias in the sample population because only producers that utilised pregnancy scanning for litter size were eligible for inclusion. Subsequently, the sampled population likely included a higher proportion of ewes that were differentially managed according to litter size compared to the general population. It is possible that producers that have adopted pregnancy scanning were more likely to adopt other management strategies that could impact reproductive performance compared to the broader population. As such, the findings of this study should only be generalised to Australian sheep producers that have adopted pregnancy scanning and should not be extrapolated across the national sheep flock.

Reproductive Performance in Maiden and Multiparous Ewes

Marking rate, reproductive rate and lamb survival for maiden and multiparous ewes are shown in Figure 1. A key difference between maiden ewe lambs and maiden Merino two-tooth ewes and both multiparous ewes was the wider variation in lamb survival and, to a lesser extent, reproductive rate and marking rate between flocks (Figure 1).

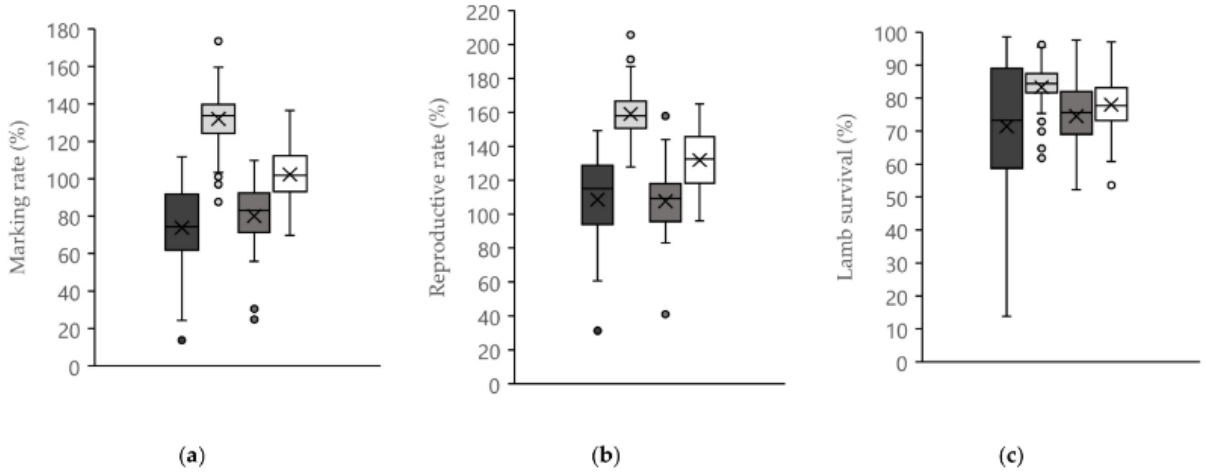

Figure 1 Box and whisker plot for (a) marking rate, (b) reproductive rate and (c) lamb survival in maiden ewe lambs, Merino two-tooth ewes and equivalent multiparous ewes. ■ Maiden non-Merino ewe lambs. □ Multiparous non-Merino ewes. ■ Maiden Merino two-tooth ewes. □ Multiparous Merino ewes

Maiden ewes had a lower marking rate, reproductive rate and lamb survival compared to multiparous ewes on the same farm. The average difference in marking rate between maiden

and multiparous ewes was 58% for non-Merino ewe lambs and 22% for maiden Merino two-tooth ewes. Lower marking rate in ewe lambs was attributable to differences of 51% for reproductive rate and 16% for lamb survival. The poorer marking rates of maiden Merino two-tooth ewes compared with their multiparous counterparts was largely attributable to a 24.4% difference in reproductive rate, whilst the difference for lamb survival was only 3% (Table 1).

Table 1 Comparisons between maiden and mature multiparous ewes for reproductive rate, marking rate and lamb survival with mean ± standard error, 95% confidence interval (95% CI) for the difference and non-parametric related samples Wilcoxon signed-rank test.

	Ewe Age Group Mean ± Standard Error		Difference	
	Maidens	Multiparous	Mean (95% CI)	*p*-Value
Non-Merino ewe lambs				
Marking rate (%) [A]	73.8 ± 2.8	131.9 ± 2.0	−58.1 (−64.3, −51.9)	< 0.001
Reproductive rate (%) [B]	108.6 ± 3.7	159.1 ± 1.9	−50.5 (−59.0, −42.1)	< 0.001
Lamb survival (%) [C]	67.3 ± 1.4	83.4 ± 0.9	−16.0 (−18.8. −13.2)	< 0.001
Ewe mortality (%) [D]	2.6 ± 0.2	2.8 ± 0.2	−0.2 (−0.8, 0.5)	0.378
Merino two-tooth ewes				
Marking rate (%) [A]	80.1 ± 2.6	102.3 ± 2.2	−22.3 (−26.9, −17.7)	< 0.001
Reproductive rate (%) [B]	107.6 ± 3.3	131.9 ± 2.7	−24.4 (−29.5, −19.2)	< 0.001
Lamb survival (%) [C]	74.5 ± 1.6	77.7 ± 1.3	−3.1 (−5.8, −0.5)	0.026
Ewe mortality (%) [D]	1.7 ± 0.2	2.4 ± 0.3	−0.7 (−1.2, −0.2)	0.006

[A] Marking rate = lambs marked/ewes mated × 100. [B] Reproductive rate = fetuses scanned/ewe joined × 100. [C] Lamb survival = lambs marked (live)/fetuses scanned × 100. [D] Ewe mortality = ewe deaths between scanning and lamb marking (scanned pregnant)/ewes pregnant × 100.

Development and adoption of management strategies to improve marking rate for non-Merino ewe lambs should focus on improving both reproductive rate and lamb survival as they contributed nearly equally to the differences in marking rate compared to multiparous ewes. By contrast, the poorer marking rate of Merino two-tooth ewes compared with their multiparous counterparts were largely due to differences in reproductive rate. Nevertheless, the development and adoption of strategies to improve marking rates for Merino two-tooth ewes should also focus on improving both reproductive rate and lamb survival. In this study, lamb survival was relatively low for both two-tooth and multiparous Merino ewes, suggesting that improved lamb survival for Merino ewes across all age groups remains an issue for the Australian sheep industry.

There were moderate positive correlations between maiden Merino two-tooth ewes and their multiparous counterparts for marking rate, reproductive rate, lamb survival and ewe survival (Table 2). In contrast, there was a very weak positive correlation between ewe lambs and their multiparous counterparts for lamb survival and no correlation for reproductive rate, marking rate or ewe survival (Table 2).

Table 2 Linear regression and bivariate Pearson correlation (two-tailed) between reproductive traits in maiden ewes and corresponding measure for multiparous counterparts

	Regression			Pearson Correlation	
	Intercept	Slope	R^2	Correlation Co-Efficient	*p*-Value
Multiparous ewes vs. non-Merino ewe lambs					
Marking rate (%) [A]	32.40	0.314	0.050	0.223	0.096
Reproductive rate (%) [B]	118.29	−0.061	0.001	−0.032	0.814
Lamb survival (%) [C]	29.55	0.460	0.079	0.280	0.035
Pregnant ewe mortality (%) [D]	2.107	0.180	0.032	0.180	0.222
Multiparous ewes vs. Merino two-tooth ewes					
Marking rate (%) [A]	14.85	0.637	0.292	0.541	<0.001
Reproductive rate (%) [B]	4.21	0.783	0.426	0.652	<0.001
Lamb survival (%) [C]	11.02	0.823	0.389	0.635	<0.001
Pregnant ewe mortality (%) [D]	0.822	0.368	0.434	0.659	<0.001

[A] Marking rate = lambs marked/ewes mated × 100. [B] Reproductive rate = fetuses scanned/ewe joined × 100. [C] Lamb survival = lambs marked (live)/fetuses scanned × 100. [D] Pregnant ewe mortality = ewe deaths between scanning and lamb marking (scanned pregnant)/ewes pregnant × 100.

Development and adoption of management strategies to improve marking rate for non-Merino ewe lambs should focus on improving both reproductive rate and lamb survival as they contributed nearly equally to the differences in marking rate compared to multiparous ewes. By contrast, the poorer marking rate of Merino two-tooth ewes compared with their multiparous counterparts were largely due to differences in reproductive rate. Nevertheless, the development and adoption of strategies to improve marking rates for Merino two-tooth ewes should also focus on improving both reproductive rate and lamb survival. In this study, lamb survival was relatively low for both two-tooth and multiparous Merino ewes, suggesting that improved lamb survival for Merino ewes across all age groups remains an issue for the Australian sheep industry.

The weak and generally non-significant correlation between the reproductive performance of ewe lambs and their multiparous counterparts in the current study hinged on the more variable performance of ewe lambs. Past research suggests that variance is likely attributed to the greater effect of live weight at the start of the mating period and live weight gain during the mating period, condition score at mating and age of the breeding ewe (Adalsteinsson *et al.* 1979, Clune *et al.* 2022, Thompson *et al.* 2021, Thompson *et al.* 2019, Viñoles *et al.* 2012). This suggests that whilst strategies to increase reproductive performance in Merinos may be generalised to both maiden and multiparous ewes, there may be an opportunity to tailor development of management strategies for non-Merino ewe lambs in comparison to strategies used for non-Merino multiparous ewes.

Conclusion

Maiden ewe reproductive performance is a key area for improvement in the Australian sheep flock. This survey suggests that for non-Merino maiden ewes, reduced reproductive performance is equally attributable to lower reproductive rate and lower lamb survival and therefore both remain of high priority for future research. The reduced reproductive performance of maiden Merino ewes was largely attributable to reproductive rate which suggests future research should be directed towards increasing the fecundity of Merino maiden ewes and the survivability of the embryos to late pregnancy. Strategies specific to ewe lambs may be required because their reproductive performance was not correlated with multiparous ewes on the same farm.

A copy of the full article can be found in Hutchison et al (2022).

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Is hemp a suitable forage for sheep?

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Introduction

Industrial hemp is the low tetrahydrocannabinol (THC) variety of *Cannabis sativa L*. As a fast-growing summer annual, it presents opportunities to the livestock industry during times when green feed may be scarce, or as a by-product from the hemp industry.

Very little data exists on hemp biomass as a forage for ruminants (EFSA, 2015). The DPIRD-led project Opening the gates to hemp fed livestock in Australia is providing world-first data on nutritional value and animal performance of sheep on hemp forage, and the safety of their meat for human consumption in terms of THC residues.

The project has been divided into two phases. Phase 1, a pilot study (2020 – 2021), tested a wide range of parameters including nutrient digestibility, THC residues, animal performance and carcase traits in sheep, with the aim to guide research for the more intensive Phase 2. Phase 2 of the project is currently underway, with results expected early 2023. This article summarises results from Phase 1.

Led by DPIRD, this project is operating in partnership with ChemCentre and Charles Sturt University. AgriFutures Australia is the major project sponsor, delivered through their Emerging Industries program.

Aims

The high level aims of this research are to:

1. Provide initial data required for development of government regulation and recommendations for feeding hemp foliage to livestock.
2. Increased adoption of industrial hemp as a new forage option for irrigated and dryland farming regions (annual rainfall above 600mm) due to stronger understanding of grazing application and effect of feeding hemp on sheep productivity, nutritional value, meat quality and food safety.

The primary aims of Phase 1 were to:

1. Analyse nutritional value of post-seed harvest hemp biomass (stubbles) as a potential feed for ruminants.
2. Understand the effects of consuming hemp biomass on growth performance and carcase traits of sheep.
3. Measure cannabinoid excretion from sheep and accumulation in tissues.

Methods

The project objectives were met through a single experiment (Table 1) conducted at Charles Sturt University using 15 Merino wether sheep aged 12 months. The use and care of animals was approved by CSU Animal Care and Ethics Committee (Protocol number: A20016) and was compliant with the Animal Research Act 1985 (as amended) in accordance with the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes.

Industrial hemp biomass (variety Morpeth Late) was grown and collected by a licensed, commercial grower in the Manjimup region of South West Western Australia. Three diets were used in this trial and included industrial hemp biomass (leaf, flowering heads, stem) at 0, 28 and 56% with oaten chaff as the substitute forage. They were formulated to be a complete ration for weaners and to be balanced in energy and protein, with the only major difference between the diets being the proportion of hemp to oaten chaff.

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Table 1 Experimental phases and their respective measurements

Experimental Phase	Days	Measurements
Adaptation to diets	0-14	Liveweight (LW), dry matter intake (DMI), leftover feed (orts)
Digestibility study	15-21	LW, DMI, orts, faecal & urinary output, 1 x rumen fluid sample on day 21
Animal performance	22-56	LW, DMI, orts, 1 x blood sample on day 56
Carcase traits	56	Hot carcase weight, cannabinoid analysis of subcutaneous fat, striploin, liver & kidney fat

Results and discussion

Animal performance

Substitution of oaten straw with hemp stubble at two levels was not detrimental to feed intake, liveweight gain or carcase traits. In fact, there was a tendency for improved liveweight gain and further investigation is warranted. Overall, the results indicate hemp stubble to be a suitable replacement for cereal straw in pelleted rations.

Cannabinoid residues

Cannabinoids in the form of Δ9-THC and THCA were detected in all measured tissues but at extremely low levels (<300 µg/kg DM). Currently, regulations state zero tolerance for THC in animal tissues and this is what researchers and producers should work towards. The sheep in the current trial were given every opportunity to express cannabinoid residues via fat growth, and they were exposed to hemp for a long time (56 days). Whilst there indeed were residues, they were extremely low. This suggests there is plenty of scope to develop management practices for feeding hemp biomass to ruminants allowing their products to enter the market with zero THC. There may also be scope for Food Standards Australia New Zealand (FSANZ) to set a maximum allowable limit for THC in animal products in the future as more data becomes available.

A copy of the full report (Blake, 2021) can be found on the AgriFutures website, and more detailed results in Krebs et al (2021).

Key messages

- Hemp stubbles appear to be a suitable roughage for sheep.
- THC residues were detected, and Phase 2 is focusing on advancing understanding of cannabinoid metabolism and clearance from tissues.

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Do you use the Lambing Planner app?

If so, we're looking for your feedback!

The Lambing Planner app was developed by Department of Primary Industries and Regional Development and ASHEEP in 2017, based on the paper version. It provides detailed information about key dates, targets and management for each stage of the ewe reproductive cycle based on your joining date.

It has come time to update the app, and we want to hear from people who have used it. What do you like about the app, and what improvements would you like to see?

Please complete this 3 minute survey to tell us what you think.

SheepLinks FutureSheep Survey

DPIRD and MLA are funding a project on climate adaptation to ensure a sustainable Western Australian sheep industry.

We'd really like your input on climate change and drought-proofing your farm in this short survey: https://www.surveymonkey.com/r/FutureSheep

For further information on the project, contact Janet Conte Janet.Conte@dpird.wa.gov.au or 9368 3206.

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