

Achieving fat score targets: the costs and benefits

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Abstract. The national Lifetime Wool project has quantified the production benefits that accrue to a breeding flock of Merino ewes from actively managing their fat score at critical stages of the reproductive cycle. The GrassGro™ model was used to simulate the profitability of achieving three fat score targets (i.e. FS2.5, FS3-4% lambing and FS3-10% lambing) for a predominately grazing region (Yass) of NSW and a sheep/cereal region (Parkes). In both regions the FS3-10% flock had the highest gross margin but was also the riskiest option in terms of the variation in gross margin during the simulation period. In all cases the key driver of gross margin was the amount (and therefore cost) of supplement required to meet the fat score targets which highlights the importance of meeting the fat score targets using pasture and matching the breeding cycle to pasture availability. Merino producers can use this information to make informed decisions regarding whether or not to feed in dry years.

Keywords: Merino ewes, fat score targets, gross margin.

Introduction

Lifetime Wool is a national project developing guidelines for woolgrowers across Australia to optimise management of Merino breeding ewes (Thompson and Oldham 2004). The basis for the Lifetime Wool project is the fact that in addition to positive impacts on the ewe herself, optimised nutrition during pregnancy (based on ewe liveweight and body condition targets) has a significant positive impact on the developing foetus (Kelly et al. 1996) - progeny from better fed ewes produced more wool which was finer throughout their lives. Actively managing the nutrition of breeding ewes to meet the target of fat score 3 at critical stages of the reproductive cycle has been shown to have many positive benefits on the overall performance of a Merino flock. These include increased conception rates (Behrendt *et al.* 2006; Hatcher et al. 2006; Oldham and Thompson 2004); lower worm burdens in pregnant ewes, reduced ewe mortality during pregnancy, increased survival of progeny - particularly twins - (Behrendt *et al.* 2006; Ferguson *et al.* 2004a); higher progeny growth rates (Paganoni *et al.* 2004c), enhanced wool production and quality of the ewe (Behrendt *et al.* 2006; Paganoni *et al.* 2004b); improved progeny wool production and quality (Behrendt *et al.* 2006; Ferguson *et al.* 2004b) and increased progeny resistance to internal parasites (Paganoni *et al.* 2004a).

While many wool producers accept that optimised ewe management during the breeding cycle will have positive benefits for both the ewes and the lifetime performance of their progeny, they are questioning the economic benefits of achieving and maintaining the fat score targets. At present it is not known whether actively managing the fat score profile of breeding ewes will have a major or minor impact on profitability. Preliminary economic modelling of early work in this area suggested that targeted nutritional management of breeding ewes at key times of the reproductive cycle can increase whole farm profit - potentially by more than $5 per ewe per year (Thompson and Young 2002). The modelling found that the effects on the lifetime wool production of progeny accounted for more than 80% of the increase in profit from feeding ewes more during pregnancy (Thompson and Young 2002). However the likely economic benefits from optimised nutritional management of breeding ewes will vary with region due to differing lengths of the pasture growth seasons, stocking rate and flock genetics (i.e. fine versus broader wool types).

This paper uses the GrassGro™ model to determine the sensitivity of sheep enterprise profit, gross margin per hectare ($GM/ha), to how breeding ewes are managed during the reproductive cycle for 2 regions in NSW representative of predominantly grazing (Yass) or sheep/cereal (Parkes) enterprises.

Materials and methods

The sensitivity of sheep enterprise profit ($GM/ha) to ewe management during the reproductive cycle of Merino ewes was modelled using a computer program, GrassGro™ version 2.4.3 (Moore *et al.* 1997). Simulations were conducted for Yass (southern NSW) and Parkes (central NSW). For each location the flocks were run on the same fertilised pasture comprising annual grasses and 10% legumes with available historical weather data (1971 - 2003 for Yass and 1971 - 2001 for Parkes) and soil types typical of the regions used to ‘grow’ the pasture. Joining in the Parkes simulations commenced in mid-February with the start of lambing occurring on 15th July, while at Yass joining was a month later in mid March with lambing beginning on the 15th August. Animal production and the subsequent financial results were generated over a 33-year period for Yass and 31 years for Parkes. The pasture growth generated by GrassGro™ has been validated against measured pasture production at the Yass site (Final Report to AWI Project EC245 Sustainable Stocking Rate Decisions).

Each simulation was modelled using the same pasture, soil and weather parameters in a paddock of 100 ha with a stocking rate of 8 DSE/ha. The common inputs for each simulation are summarised in Table 1 - Appendix.

Simulated fat score profiles

The following target fat score (FS) profiles were modelled: FS2.5; FS3 with a 4 % improvement in reproductive potential (lambing %) compared to FS2.5; and FS3 with a 10 % improvement in reproductive potential compared to FS2.5. For both FS3 simulations the wool production and quality of the ewes was adjusted to reflect the biological outcomes from the Lifetime Wool project (Behrendt *et al.* 2006). For the progeny of the FS3 ewes, this was +0.1 kg clean fleece weight (CFW) and -0.1 µm fibre diameter (FD).

Sensitivity analysis

All initial runs used the wool and grain prices in Table 1 - Appendix. The wool prices are based on an average flock FD of 19 µm. The base grain price used for each region was $180/tonne, however the actual price used in the simulations was varied to take account of the inherent differences in grain prices in a grazing (i.e. Yass) versus mixed farming (i.e. Parkes) operation. The $40/tonne lower grain price for the Parkes region reflects the fact that grain would generally be available on-farm while producers in Yass would need to purchase their grain off-farm and pay an additional $30/tonne for transport and $10/tonne for agent's fees to access the grain on-farm. The sensitivity of the gross margins for each simulation was determined by decreasing the base grain price from $180/tonne to $150/tonne (i.e. with appropriate on-costs this equates to $240 to $210/tonne for Yass and $200 to $170/tonne for Parkes) and varying the wool and meat prices by -10% and +10%.

Analysis

ASReml (Gilmour *et al.* 2002) was used to determine the significance of differences between the three fat score profile flocks at the two sites.

Results

Yass region

Rainfall and pasture growth The average annual rainfall for the Yass region over the 33-year period was 758.3 mm. The average monthly rainfall ranged between 43 to 85 mm with the highest monthly falls occurring between July and October (Figure 1 - Appendix).

This average pattern of rainfall produces the first green 'pick' of pasture in April with a maximum green pasture availability of just over 2,800 kg/ha occurring in November (Figure 2a - Appendix). The peak of green pasture is followed in January by a peak of 3,000 kg/ha of dead plus litter availability which declines as the summer and autumn progresses (Figure 2b - Appendix). The average duration of green pasture availability at Yass is 9 months (April to December). The percentiles for green (Figure 2a - Appendix) and dead (Figure 2b - Appendix) pasture availability for the best 10% of years and worst 10% of years clearly show the variation in the length of the growing season for Yass - from 11 months (February to December) in the best 10% of years to only 6 months (June to November) in the worst 10%.

Target fat score profiles In average years there was little difference between the FS2.5 and FS3 target fat score profiles from January to April. During this period both flocks lost nearly an entire fat score from their peak in December (Figure 2a - Appendix).

Maintaining the fat score target of 3 required an average of 9 kg/ha more maintenance supplement than the FS2.5 flock (Table 2 - Appendix). There was little difference in the maintenance level of supplement fed between the two FS3 flocks.

Income and costs The FS3-10% flock generated the highest average income of $503.40/ha followed by the FS3-4% and FS2.5 flocks ($491.10 and $460.50/ha respectively). The differences between the three flocks were largely the result of the increased wool and meat income from both the ewes and their progeny in the FS3 flocks (Figure 3a - Appendix), due to higher numbers of progeny shorn and sold in the FS3 flocks as well as the higher CFW and finer FD of the FS3 fleeces (Table 2 - Appendix).

The FS3-10% flock had the highest expenses of the three flocks followed by the FS3-4% and FS2.5 flock ($241.90, $237.5 and

$214.00/ha respectively). The difference in costs between the three flocks was due to the higher amount (and therefore cost) of maintenance supplement fed to the FS3 flocks (Figure 3b - Appendix).

Gross margin The average gross margins of the three flocks were all significantly different from each other (P<0.001). The FS3-10% flock had the highest average gross margin of the three flocks ($208.55/ha), followed by the FS3-4% ($200.58/ha) and the FS2.5 flock ($193.45) (Table 2 - Appendix). The FS3-10% flock tended to be the 'riskiest' in terms of the variation in gross margin over the 33 years as the standard deviation of gross margin for this flock ($107) was significantly higher than that of the FS2.5 flock ($99) (P<0.01) (Figure 4 – Appendix). There was no significant difference in standard deviation of gross margin between the FS3-10% and FS3-4% ($104) flocks nor between the FS2.5 and FS3-4% flocks. No significant differences were evident between the three flocks in the coefficient of variation (CV) of gross margin.

The longer lower 'whiskers' of the box plot (Figure 4 – Appendix) clearly shows that the variability of gross margin is higher in worst 25% of years compared that occurring in the best 25% of years. In fact, for 15% of years during the simulation period the gross margin was less than the $100/ha overhead costs for all three fat score profiles (Table 2 – Appendix).

Sensitivity analysis The average gross margin for each of the three flocks was more sensitive to fluctuations in wool and meat prices than to changes in grain prices. At both low and high grain prices the average gross margin was negative when market prices were low for all three flocks.

Parkes region

Rainfall and pasture growth The average annual rainfall for the Parkes region over the 31 year period was 656.6 mm. Compared to Yass, Parkes experiences less variation in rainfall distribution during the year (Figure 5 - Appendix) with a lower range in average monthly falls (40-73 mm).

This average pattern of rainfall produces the first growth of green pasture in April with a maximum green pasture availability of just over 2,100 kg/ha in October (Figure 6a - Appendix). The peak of green pasture is followed in November with a peak of 2,000 kg/ha of dead plus litter availability which declines as the summer and autumn progresses (Figure 6b - Appendix). The average length of the green pasture availability for Parkes is 7 months (May to November). The percentiles for green (Figure 6a - Appendix) and dead (Figure 6b - Appendix) pasture availability for the best 10% of years and worst 10% of years show that the growing season in Parkes is shorter on average than that at Yass from 9 months (March to November) in the best 10% of years to only 4 months (July to October) in the worst 10%.

Target fat score profiles In average years the 0.5 difference in fat scores between the FS2.5 and FS3 flocks is maintained from February until August (Figure 6a - Appendix). From November to January there is little difference in fat score between the flocks. The FS3 flocks required nearly 11.5 kg more maintenance supplement than the FS2.5 flock (Table 3 - Appendix).

Income and costs The FS3-10% flock generated the highest average income of $464.61/ha followed by the FS3-4% and FS2.5 flocks ($450.71 and $423.55/ha respectively). The differences between the three flocks were again mainly due to higher wool and meat income from both the ewes and their progeny in the FS3 flocks (Figure 7a - Appendix).

The FS3-10% flock again had the highest expenses of the three flocks followed by the FS3-4% and FS2.5 flock ($325.74, $319.39 and $293.77/ha respectively). The difference in costs between the three flocks was due to the higher amount of maintenance supplement required by the FS3 flocks to maintain their condition relative to the target profile (Figure 7b - Appendix).

Gross margin The average gross margins of the three flocks were all significantly different from each other (P<0.001). The FS3-10% flock had the highest average gross margin of the three flocks ($139.26/ha), followed by the FS3-4% ($120.09/ha) and the FS2.5 flock ($116.35). The FS3-10% flock again tended to be the 'riskiest', as the standard deviation of gross margin for this flock ($124) was significantly higher than that of the FS2.5 flock ($115) (P<0.01) (Figure 8 – Appendix). There was no significant difference in standard deviation of gross margin between the FS3-10% and FS3-4% ($121) flocks nor between the FS2.5 and FS3-4% flocks. No significant differences were evident between the three flocks in the CV of gross margin.

The variability of gross margin was greatest during the worst 25% of years compared to the variation occurring during the best 25% of years as evidenced by the relative size of the 'whiskers' extending from each end of the box plot for each of the three fat score profiles (Figure 8 – Appendix). In nearly one third of the years during the simulation period the gross margin was less than the $100/ha overhead costs for all three fat score profiles (Table 3 – Appendix).

Sensitivity analysis The average gross margins for each of the three flocks appear to be more sensitive to changes in market prices for wool than to changes in grain prices.

Discussion

The profitability of sheep enterprises ($GM/ha) at both Yass and Parkes is sensitive to how the breeding ewes are managed during the reproductive cycle. For both regions the FS3-10% flock had the highest gross margin but was also the 'riskier' in terms of variability in gross margin, evaluated by the standard deviation of gross margin. The key driver of gross margin for the various fat score target profiles across both regions was the amount of maintenance supplement required to achieve the fat score targets. There was a strong inverse relationship (r^2 = 0.93) between the amount of maintenance supplement fed and the resulting gross margin regardless of the particular target fat score profile or region (Figure 9 - Appendix). This highlights the importance of meeting the fat score targets using pasture and matching the breeding cycle to pasture availability.

As the amount of supplement fed was the main cause of variation in gross margin, any improvement in the efficiency with which supplements are fed to and utilised by a breeding flock will have a significant positive impact on the sheep enterprise gross margin. Development of targeted feeding strategies based on the particular nutritional requirements of segments of the flock, single versus twin bearing ewes for example, at critical stages of the reproductive cycle is one option. A recent economic assessment of targeted nutrition for ewes and weaners using various e-sheep technologies indicated that the cost of feeding a thousand-ewe flock could be reduced from $14,000 for feeding all animals to $3,300 for targeted feeding of 25% of ewes requiring additional nutrition and 20% of weaners at risk of dying (Jordan *et al.* 2006). In the absence of e-sheep technologies, strategies such as simply drafting off the lighter ewes and weaners in the mob and providing them with better pasture than the rest of the mob or providing additional supplement will also be effective.

For all these simulations a set-stocking rate of 8 DSE/ha was used, as this is a reflection of the average district-stocking rate for both the Yass and Parkes regions. However using the same stocking rate for each of the three target fat score profiles assumes that the 'optimum' stocking rate for each is similar. It is possible that the optimum stocking rates are different which may result in an unfair comparison of an optimal with a sub-optimal system. Definition of an optimal stocking rate is difficult as it varies between properties according to the length of the growing season, the timing of enterprise events such as the time of lambing relative to the peak of pasture availability and quality, producers attitudes towards hand feeding and environmental sustainability (ie maintenance of adequate ground cover) and the availability of farm labour (Alcock 2006). A method summarised by Donnelly *et al.* (1988) was used to estimate the economic optimal stocking rate for each of the three target fat score profiles. Additional GrassGro™ simulations over the 31 year period were undertaken for three fat score profiles in the Parkes region using stocking rates ranging from 5.3 to 19.3 DSE/ha. For FS3-10% flock, the average GM/ha increased with increasing stocking rate up to 11 ewes/ha, further increases in stocking rate resulted in lower GM/ha and higher between year variation (Figure 10 – Appendix). Therefore 11 ewes/ha represents the 'economic' optimum stocking rate as the increased variability in GM/ha is not offset by further increases in average GM (Alcock 2006). Both the FS2.5 and FS3-4% flocks had similar 'optimum' stocking rates. The average gross margins at the 'optimal' stocking rate was $168.21, $173.39 and $183.86 for the FS2.5, FS3-4% and FS3-10% flocks respectively which was between $45 (FS3-10%) and $53 (FS3-4%) more than the average gross margin at 8 DSE/ha for the simulations reported in this paper. Therefore although less than optimal stocking rates were used to compare the three fat score profile flocks in this paper, the impact of comparing sub-optimal systems on the gross margin for each was similar

In order to put the impact of achieving the target fat score of 3 into perspective with other potential flock management decisions we compared the results of these simulations with the impact of reducing stocking rate. This was done for the Yass site using the average wool prices shown in Table 1 – Appendix and a grain price of $240/tonne. The stocking rate of the FS3-4 % ewe flock was reduced until the cost of the maintenance supplement/ha was the same as that for the FS2.5 flock. This reduced the stocking rate by 1.7 ewes/ha to 6.3/ha and the gross margin by $33/ha (i.e. $168 versus $210/ha) compared to the feeding strategy to maintain fat score 3 and a stocking rate of 8/ha. It was also $30/ha less than the FS2.5 simulations (i.e. $168 versus $198/ha). The overall impact of reducing stocking rate is to reduce income in good years which more than outweighs the benefits of a lower stocking rate in the poor years. This finding highlights the balance that must be reached between optimising stocking rate from an economic perspective versus managing a flock for maximum individual performance. Optimisation of whole farm stocking rate in the face of fluctuating feed supplies will undoubtedly lead to sub-optimal management of the breeding ewe to achieve less than maximum rates of production for both herself and her progeny. The Lifetime Wool project is seeking to quantify the full range of consequences occurring from manipulating ewe nutrition to increase our ability to predict whole system outcomes from changes in ewe management and fluctuating feed supply during the breeding cycle.

Conclusions

Sheep enterprise profit is sensitive to ewe management during the reproductive cycle of Merino ewes. The relative riskiness of managing Merino flocks to achieve fat score targets in different regions can be assessed by comparing the FS2.5 and FS3 fat score profiles for the ewes during the best 10% of years and the worst 10% of years (Fig 13 - Appendix). In 'good' years (i.e. 90% decile) there is little difference in the average fat score of the two flocks and the FS2.5 flocks are able to outperform their target and will more than likely realise most of the benefits of optimal ewe nutrition identified by the Lifetime Wool project with little additional supplement required in order to do so. However in 'bad' years (i.e. 10% decile) the 0.5 difference in fat score between the two flocks is maintained almost year round. In this situation the FS2.5 flock (and the FS3 flock) will require significantly more supplement with the subsequent negative impact on gross margin.

For both regions and for all three fat score profiles the variation in gross margin in the 25% of poor years was nearly double that occurring in the 25% of best years (ie the lower 'whiskers' of each of the box plots was more than twice the length of the upper 'whiskers'). In poor years there was high risk, between 15 and 29% of the sheep enterprises under simulation not generating enough returns to cover the overhead costs of the enterprise.

Producers can use this type of information to make an informed decision about the consequences of not feeding in dry (or riskier in terms of gross margin) years in order to manage year-to-year variation in gross margin. This decision will need to be made before joining and the break of the season. In dry autumns producers may need to accept a lower fat score target and acknowledge the production penalties (i.e. reduced conception and poorer ewe and progeny wool production and quality) that are likely to occur as a result with a view to balancing the impact of cost of supplements with gross margin/ha. In bad years the decision to feed should be controlled by ewe condition in relation to ewe survival especially if winter shearing is part of the management routine.

The FS3-10% flock outperformed the FS3-4% flock in both regions in terms of average gross margin. However it is important to recognise the importance of achieving the improvement in reproduction though increasing flock fertility rather than by simply increasing the bodyweight of the ewes. If the improvement in reproduction occurs with a concurrent increase in bodyweight this will have a negative impact on gross margin, as stocking rate will necessarily be reduced.

An additional advantage of the 10% reproduction rate that was not taken into account in these simulations is the greater rate of genetic progress that will occur in the FS3-10% flocks due to larger progeny numbers and resultant higher selection intensity. For 19µm wool, using the 2000 - 2005 wool prices, a 10% improvement in reproductive rate is worth $0.84 to $1.14/ewe from increased selection pressure (OFFM calculator ver.5).

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Appendix

Table 1. Common inputs for the GrassGro™ simulations.

Wool prices				
Fibre diameter	18	19	20	21
Fleece price (c/kg)	1152	990	810	717
Average fleece price	90%			
Commissions & tax	5%			
Lamb prices				
Carcase price	250 c/kg DW			
Carcase yield	40%			
Skin price	1			
CFA prices				
Carcase price	150 c/kg DW			
Carcase yield	40%			
Skin price	1			
Costs				
Shearing costs	$5/hd			
Lamb shearing cost	$5/hd			
Husbandry cost	$5/hd			
Lamb husbandry cost	$3/hd			
Cost of replacements	$40/hd			
Cost of rams	$800/hd			
Commission on sales	4%			
Other sale costs	1.2/hd			
Maintenance supplement	Yass $240/tonne		Parkes $200/tonne	
Production supplement	$150/tonne			
Cost of pastures	$40/ha			
Overhead costs	$100/ha			

Figure 1. Average monthly rainfall for the Yass region (1971 - 2003)

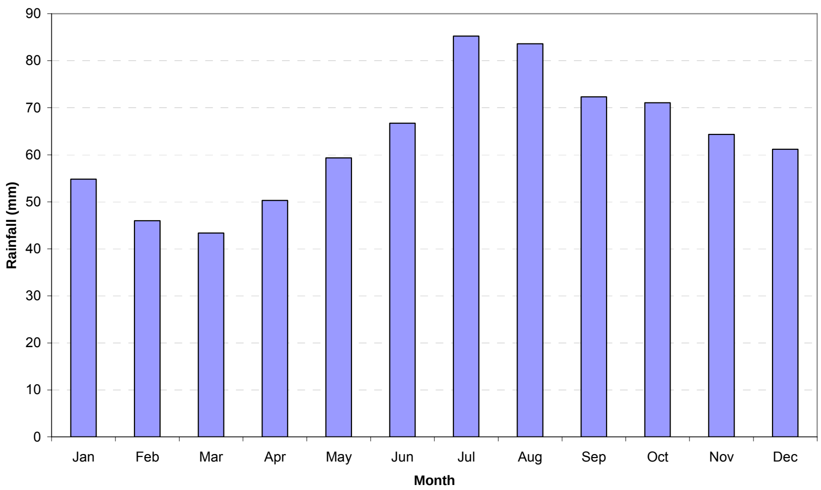


Figure 2. Average available a) green and b) dead plus litter pasture (kg/ha) along with the 90 and 10% deciles for the Yass region (1971 - 2003)

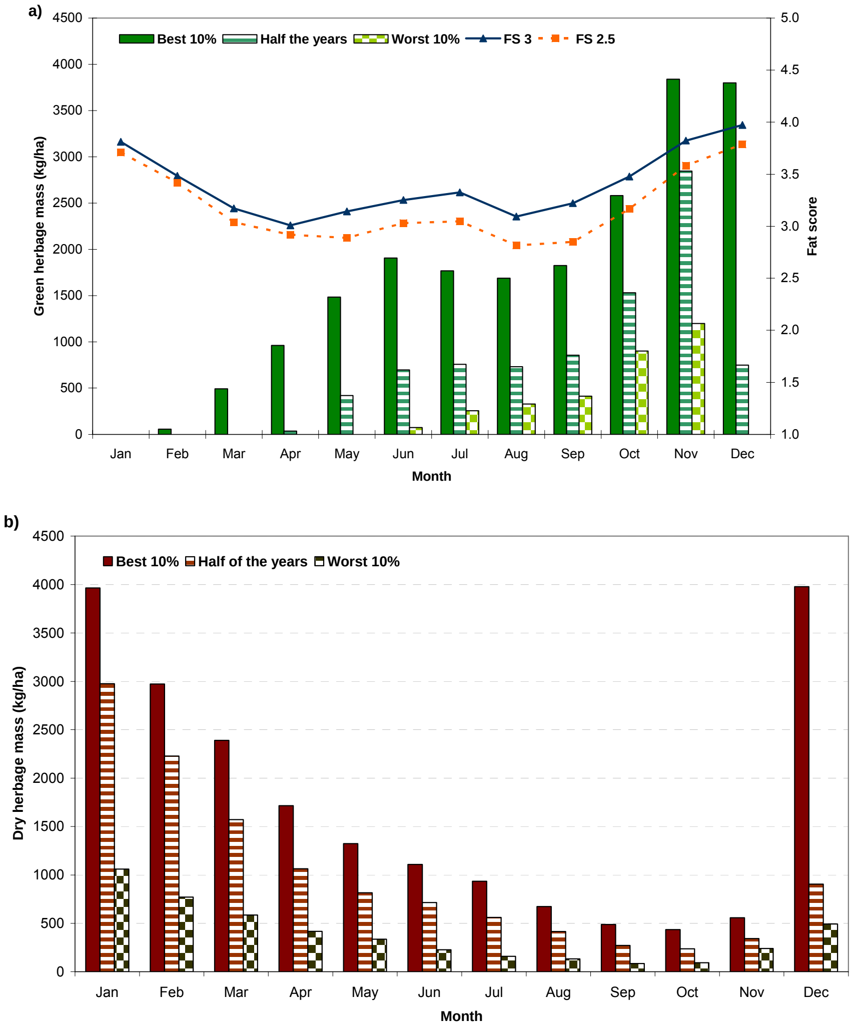
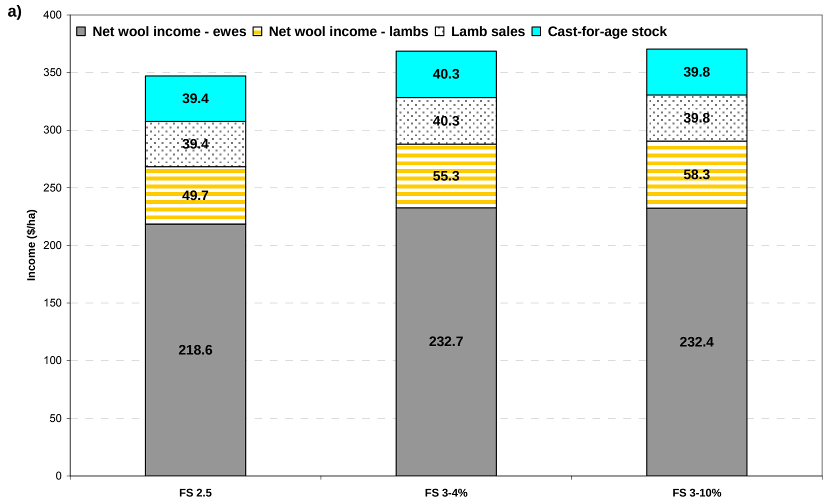


Table 2. Simulation outputs for Yass region

Output	FS2.5	FS3 4%	FS3 10%
Ewes shorn	769	769	768
CFW (kg)	3.83	3.91	3.92
FD (µm)	19.48	19.40	19.41
Lambs shorn	635	660	695
CFW (kg)	1.15	1.18	1.18
FD (µm)	19.96	19.89	19.88
Wether lambs sold	318	330	348
LWT (kg)	29.9	30.2	30.0
Fat score	2.8	2.8	2.8
Ewe lambs sold	171	184	201
LWT (kg)	27.3	27.6	27.4
Fat score	3.0	3.8	3.0
Maintenance supplement fed (kg/ha)	28.3	37.1	37.4
Average Gross Margin ($/ha)	193.45	200.58	208.55
% years where overhead costs >GM/ha	15	15	15

Figure 3. Breakdown of a) average income and b) average costs for the Yass region for the three fat score profile flocks (1971-2003).



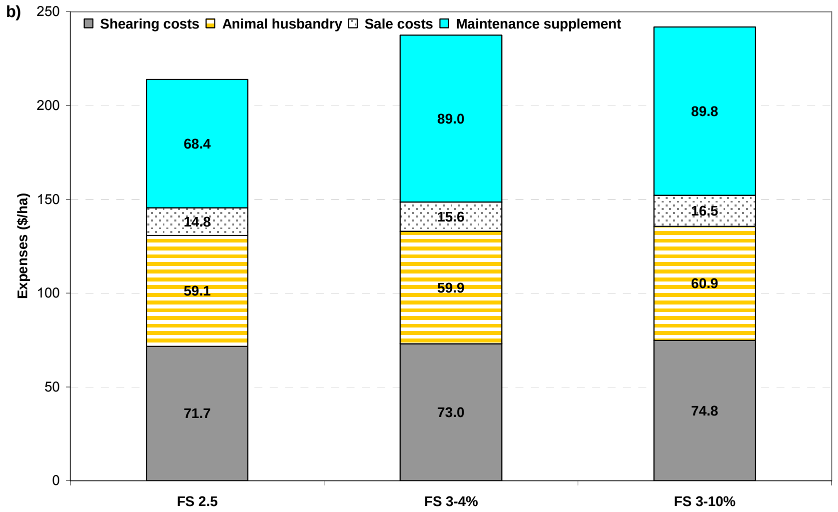


Figure 4. Variability of gross margin ($/ha) from the GrassGro™ simulations for Yass (1971-2003). The average GM is represented by the '+', the box represents the upper and lower quartile around the median and the whiskers above and below the box depict the statistical extremes of the distribution. Outliers are represented by an asterisk.

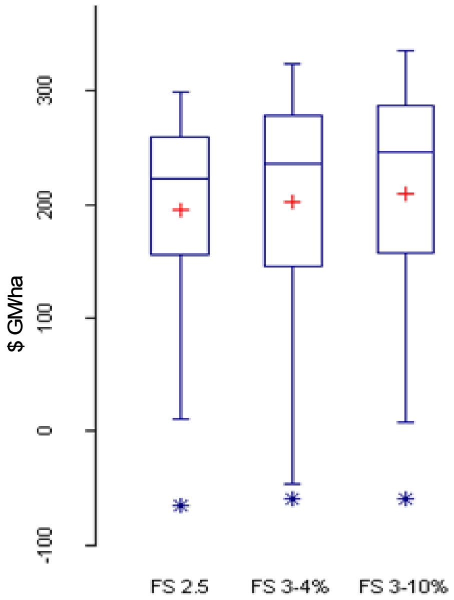


Figure 5. Average monthly rainfall for the Parkes region (1971 - 2001)

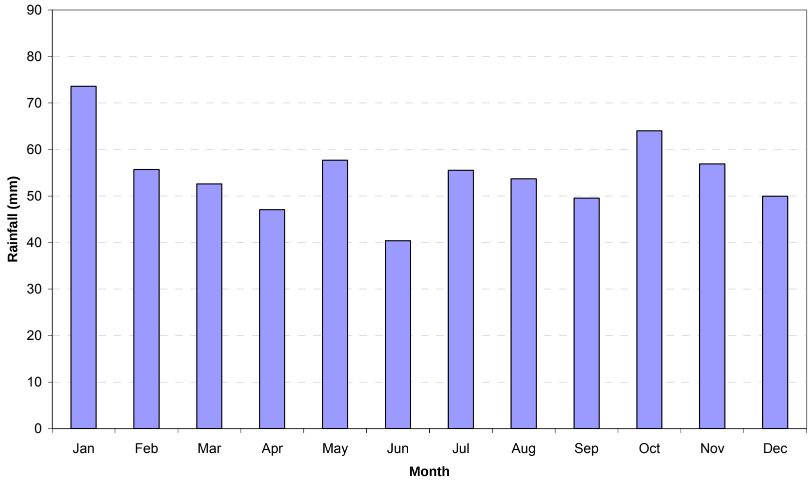
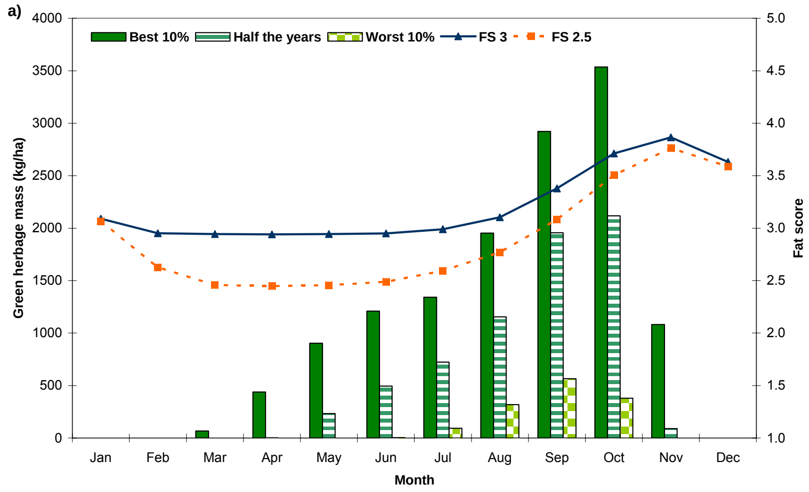


Table 3. Simulation outputs for Parkes region

Outputs	FS 2.5	FS 3 4%	FS 3 10%
Ewes shorn	708	707	710
CFW (kg)	3.34	3.42	3.42
FD (μm)	18.69	18.49	18.49
Lambs shorn	552	578	612
CFW (kg)	1.37	1.41	1.40
FD (μm)	19.68	19.46	19.43
Wether lambs sold	276	289	306
LWT (kg)	29.95	30.28	29.97
Fat score	2.3	2.1	2.1
Ewe lambs sold	148	160	177
LWT (kg)	27.4	27.29	26.99
Fat score	2.5	2.2	2.2
Maintenance supplement fed (kg/ha)	55.60	67.09	68.47
Average Gross Margin ($/ha)	130.23	131.71	139.26
% years where overhead costs >GM/ha	29	29	29

Figure 6. Average available a) green and b) dead plus litter pasture (kg/ha) along with the 90 and 10% deciles for the Parkes region (1971 - 2001)



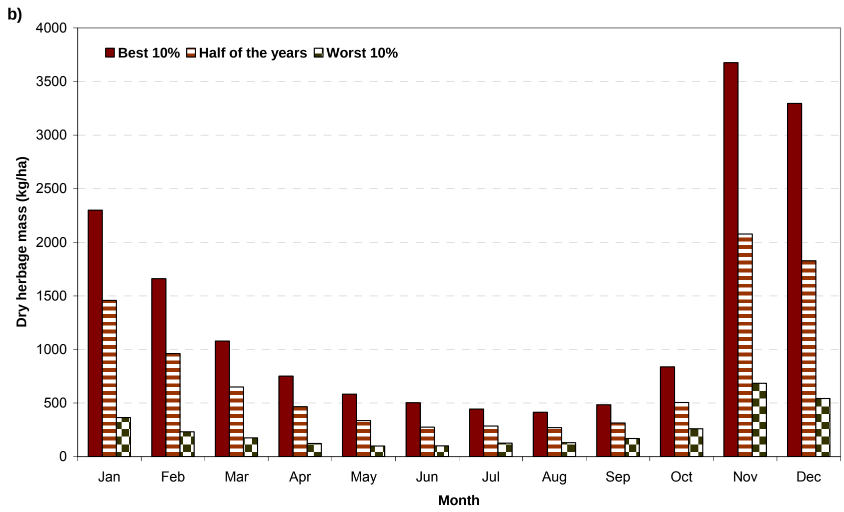
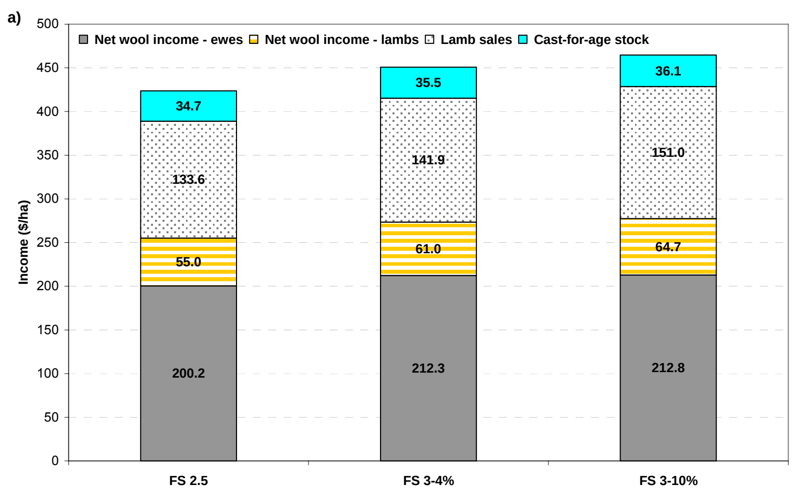


Figure 7. Breakdown of a) average income and b) average costs for the Parkes region for the three fat score profile flocks (1971-2001).



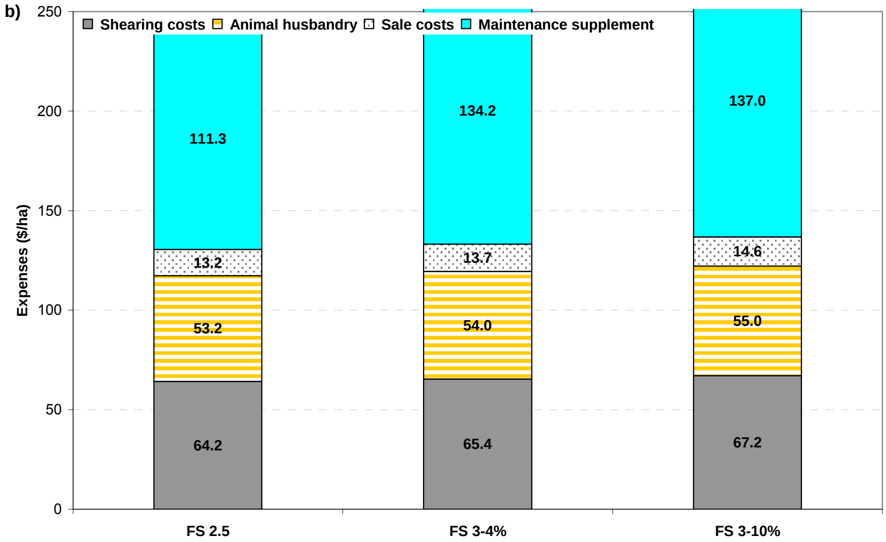


Figure 8. Variability of gross margin ($/ha) from the GrassGro™ simulations for Parkes (1971-2001). The average GM is represented by the '+', the box represents the upper and lower quartile around the median and the whiskers above and below the box depict the statistical extremes of the distribution.

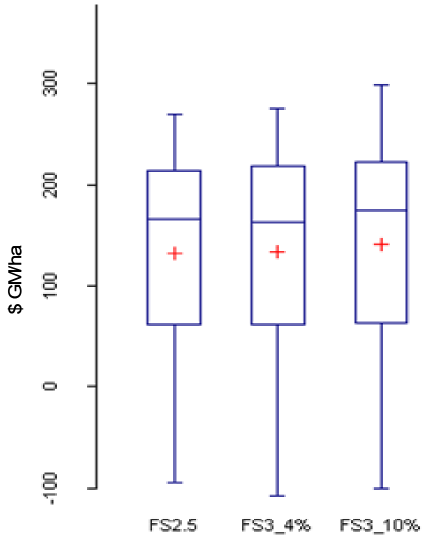


Figure 9. Relationship between maintenance supplement fed and gross margin.

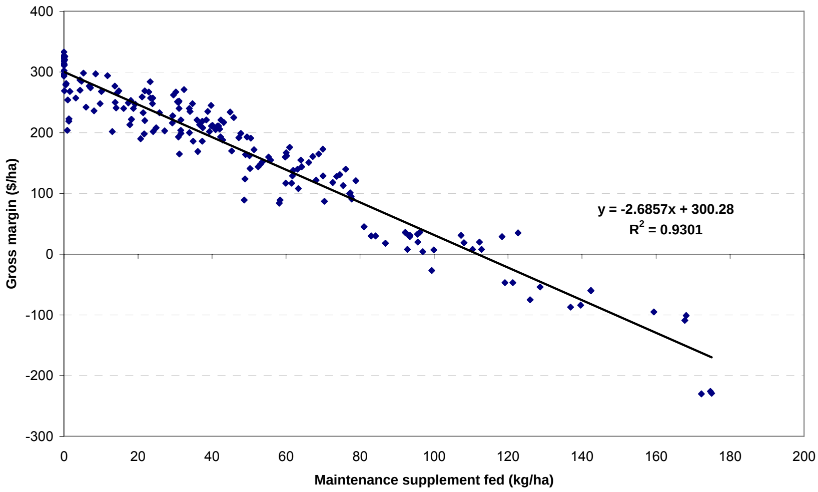


Figure 10. Variability of gross margin ($/ha) from the GrassGro™ simulations at Parkes (1971-2001) for the FS3 10% fat score profile at stocking rates ranging from 5.3 to 19.3. The average GM is represented by the '+', the box represents the upper and lower quartile around the median and the whiskers above and below the box depict the statistical extremes of the distribution.

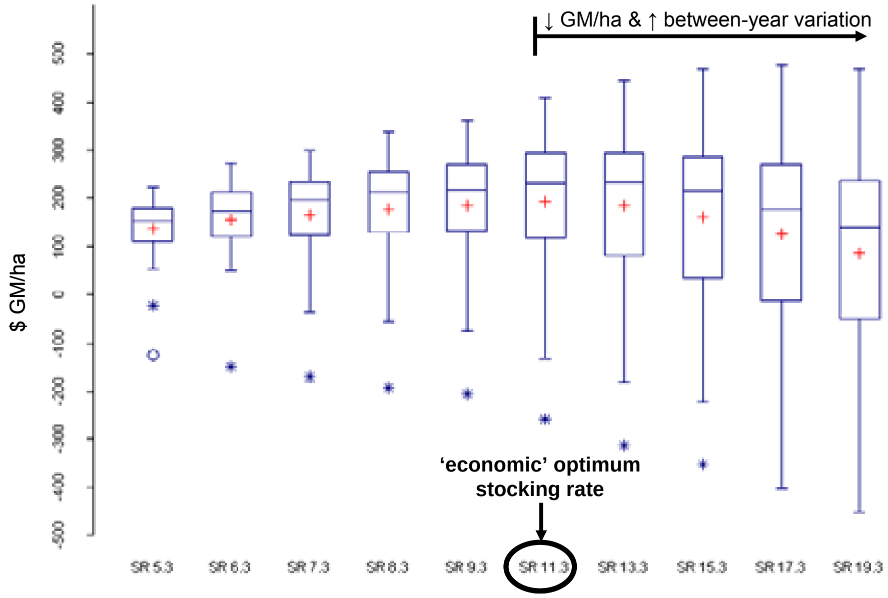
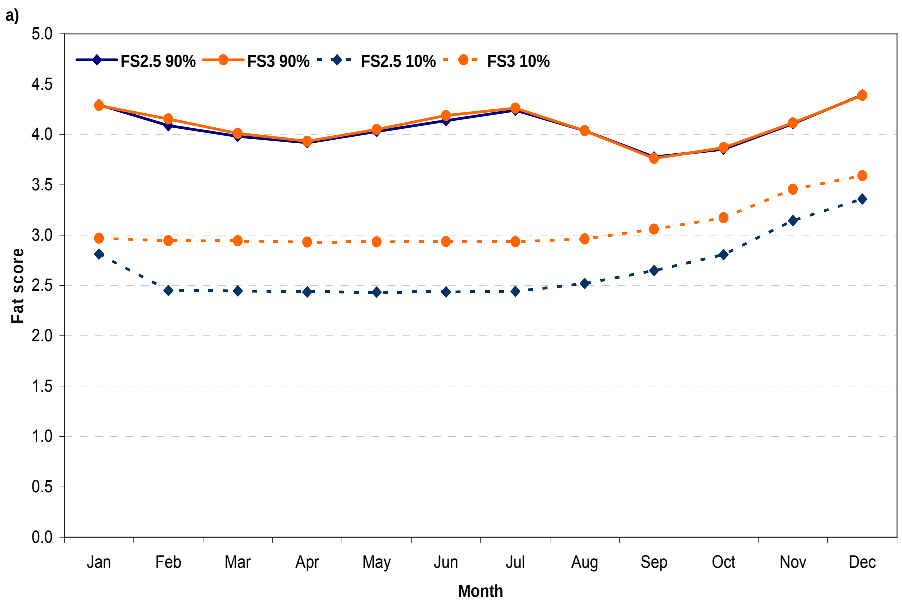
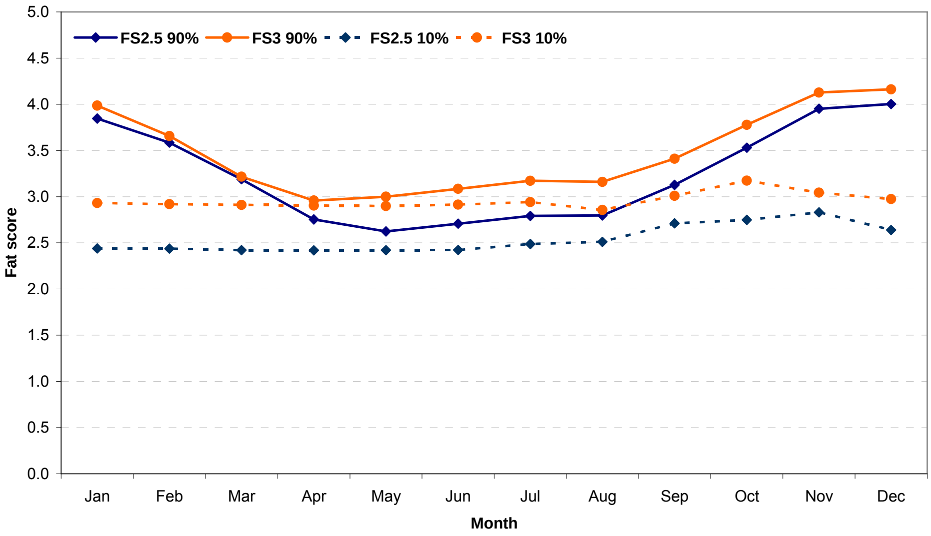


Figure 11. 90 and 10 % deciles for fat score profiles for FS2.5 and FS3 targets for a) Yass and b) Parkes



b)


FS2.5 90%
FS3 90%
FS2.5 10%
FS3 10%
Fat score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month