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POTENTIAL BENEFITS OF PRECISION NUTRITION TO INCREASE REPRODUCTIVE EFFICIENCY UNDER GRAZING CONDITIONS

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SUMMARY

Recent development in automatic sheep management systems based on radio frequency tags, in-race readers and automatic drafting equipment creates opportunities for strategic nutritional management of individual animals. This paper describes a simple simulation model for investigating the implications of different supplementary feeding systems in terms of potential benefits of increased lambing percentages. Four different feeding systems are compared: (i) feeding each animal according to its individual requirements to reach a weight of 52 kg prior to joining; (ii) feeding 0.3 kg daily to each animal; (iii) feeding the same amount of feed as in (ii) but given twice per week to the whole group; and (iv) as for (iii), but with variation in intake randomly allocated across all weight ranges. Feed conversion efficiency (FCE) was set at 8:1 for twice weekly feeding and at 5:1 for daily feeding. Although the highest lambing percentage was achieved using the feeding system in scenario (i), the most profitable feeding regime was (ii). The results confirm that feeding restricted amounts of supplement twice weekly may not be a cost-effective way of increasing ovulation rate and lambing percentage. On the other hand, precision nutrition, in conjunction with electronic sheep management systems, may increase efficiency and profitability of the ewe flock. Although the current study deals only with lambing rate, it is likely that precision nutrition may be cost-effective in managing ewe nutrition prior to lambing. New methods of feeding management and feed preparation may be needed to get the most value from computer-based feed management systems.

*Keyword*s: sheep nutrition, precision feeding, electronic sheep management

INTRODUCTION

An increase in the value of sheep meat in recent years has focused the attention of many sheep producers on using rams to improve carcase characteristics and nutritional management to improve reproductive efficiency. One of the best documented relationships between nutritional status and reproductive efficiency is that between live weight (condition score) and ovulation rate. Edey (1968) showed that ovulation rate increased by up to 4% per kg of liveweight and this finding has been supported by a number of subsequent studies. In addition to liveweight *per se*, the level of nutrition immediately prior to ovulation can also have a major effect on ovulation rate (Coop 1966; Lightfoot *et al.* 1976). Despite the clear evidence of good responses in ovulation and lambing rates to improved nutrition prior to joining, this management option has not been widely adopted. The reason is that it is very rarely profitable to feed the whole ewe flock for the sole purpose of increasing ovulation rate using conventional methods of supplementary feeding. Animals fed twice weekly have lower growth rates (Rowe *et al*. 1985) and higher substitution rates than when the same feed is provided daily. In addition, there is between animal variation in the amount of feed eaten when restricted amounts of feed are available in troughs or trailed on the ground (Franklin *et al*. 1955). This means lighter animals that most require supplementary feed are least likely to receive the allocated amount while heavier animals consume more than their share.

The development of electronic sheep management systems based on radio frequency (RF) transponder eartags, in-race readers and automated drafting systems will almost certainly create new opportunities for strategic nutritional management of individual animals using pre-set criteria such as liveweight and rate of weight change. Animal enacted walk-through weighing systems are under development for use in the sheep and other livestock industries, and it is important to investigate how this technology may be used in nutritional management of grazing animals. This paper describes a simple simulation model and its use for evaluating the benefits and costs of different systems of nutritional management to increase ovulation rate and lambing percentage in a flock of Merino ewes.

MATERIALS AND METHODS

Four scenarios were developed to define the costs and benefits of different feeding systems for a group of 1000 ewes with a mean liveweight of 45 kg (s.d. ± 2.3). The results of Edey (1968) and Rowe *et al.*

(1985) were used to predict ovulation rates for ewes of different liveweight (Figure 1). Reproductive wastage was assumed to be 40% of the number of ova shed in terms of lambs born (Walker *et al.* 2003). A constant figure of 60% lambs per ova shed was used for all scenarios. The following assumptions were used for all feeding scenarios: cost of feed $250/t; FCE 5:1 for daily feeding; and FCE 8:1 for twice weekly feeding. It was assumed that the value of each additional lamb resulting from supplementary feeding was $45. It is important to emphasise that all assumptions made in this paper with respect to value of feed and lambs, as well as feed conversion ratios, can be variable and can have a major impact in determining costs and benefits.

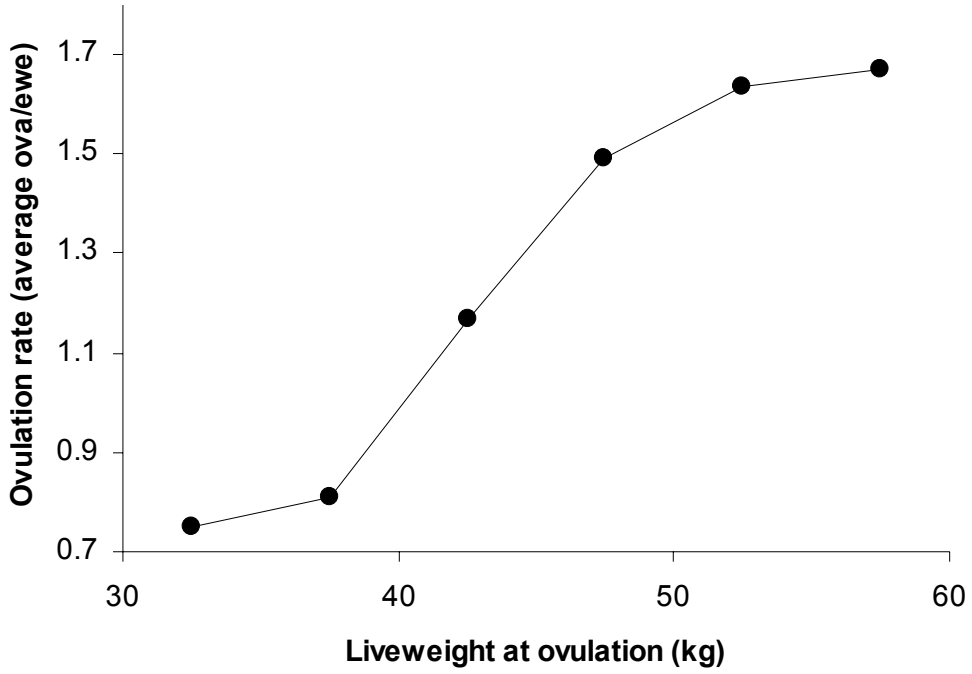

Figure 1. Relationship between liveweight and ovulation rate in Merino ewes (from Edey (1968); and Rowe *et al*. (1985)).

Scenario 1. Ewes were fed supplements of up to 1 kg each day in order to meet a target joining weight of 52 kg assumed to result in a maximum potential ovulation rate of 1.7. Under this regime, ewes were fed for variable periods depending on their starting weight and the amount of weight gain required to meet the target joining weight. This model assumes that sheep can be weighed daily and only those animals requiring additional weight gain are given access to feed.

Scenario 2. All ewes were fed a supplement of 0.3 kg each day for 6 weeks prior to joining and it was assumed that all ewes consumed the specified level of supplement every day. This assumption would only be valid with an automatic feeding system operating with a computer-based RF transponder controlling access to measured amounts of feed.

Scenario 3. The same feed regime as for Scenario 2, except that animals were fed in a single group, and feed intake was adjusted so that heavier animals consumed more feed than lighter animals. Feeding was twice per week with the assumption that feed conversion ratio was less efficient (8:1) than for daily feeding (feed conversion ratios were 8:1 and 5:1, respectively).

Scenario 4. As for Scenario 3, except that feed conversion was increased to 20 kg feed per kg of liveweight gain for one third of the ewes. This assumption aimed to simulate variable response to supplementary feeding, and the fact that a proportion of grazing animals reduce pasture intake when fed a supplement and gain weight far more slowly than predicted.

The cost of sophisticated systems of animal management and feeding required for scenarios 1 and 2 have not been built in to the cost of feeding for these scenarios. There are 2 reasons for this approach.

Firstly, the 'new-generation' feeding and animal handling systems will almost certainly cater for weekly 'top-up' of feed silos rather than twice weekly trail feeding and there will be savings, not additional costs, associated with this regime. Secondly, the cost of electronic animal management systems such as RF tags, readers and data management systems will spread across multiple facets of the sheep production enterprise and a costing for the strategic feeding component is difficult. The estimated benefit – cost for each feeding scenario gives an indication of whether use of electronic sheep management and precision feeding systems should be considered against other investments.

RESULTS

Different feeding strategies can influence the potential profitability of supplementary feeding to increase reproductive efficiency (Table 1). Twice weekly feeding regimes had reduced benefits relative to other scenarios due to a lower feed conversion ratio associated with interval between feeding and unequal distribution of feed intake between sheep. The situation simulated in scenario 3 is likely to be common in commercial feeding systems where heavier animals consume more of a restricted amount of supplement than lighter animals. The results of the current study indicate that high levels of intake by heavier animals, that will not respond to supplements through increased ovulation rate, and corresponding low level of intake by lighter animals, that have the potential to respond, are more detrimental than random variation in intake across all weight ranges.

The simulated results emphasise the importance of reproductive efficiency when additional lambs are valued at $45. The difference between 84 and 90% lambing percent for scenarios 3 and 2 represents approximately $2500 over 1000 ewes for the same cost of feed and suggests that there is potential value in sophisticated feed management systems provided these systems are robust and costs are commensurate with the anticipated benefits.

Table 1. Summary of the predictions for 4 hypothetical scenarios of supplementary feeding of ewes prior to joining. Estimated lambing percent for ewes fed no supplement was 78%. Assumptions with respect to costs of feed and value of additional lambs are described in the text.

	1 Daily feeding to reach optimal joining weight	2 Feeding 0.3 kg supplement daily to each animal	3 Feeding twice weekly with heavier animals eating more than lighter	4 Twice weekly feeding with variable intake across all weight groups
Lambing %	102	90	84	85
Value of extra lambs	$10,710	$5,158	$2,693	$3,120
Cost of feeding	$8,764	$3,150	$3,150	$3,150
Benefit/cost of feeding	$1,946	$2,008	($457)	($30)
Return (% of feed cost)	22%	64%	-15%	-1%

DISCUSSION

The most cost effective strategy for increasing ovulation rate and lambing percentage is likely to be a combination of scenarios 1 and 2. That is, to feed only those ewes needing additional nutrition and making the supplement available daily in a way that ensures the appropriate level of intake for each animal. It is likely that cost effective technology will soon be available to draft animals for a daily feed of supplement on the way to water, or when moving between paddocks. On the other hand although there is already technology for automatically providing pre-weighed feed to individual cattle, the cost of this equipment for sheep is likely to prevent commercial use in the foreseeable future.

Another benefit of regularly monitoring the weight of animals during periods of supplementary feeding will be the ability to quickly identify those animals not responding to supplementary feed. Targeting those animals likely to increase weight, condition score and ovulation rate can further reduce the cost of feeding.

Benefits from supplementary feeding, estimated in this simple analysis, are likely to be conservative since they are restricted to the value of additional lambs born and raised. Other benefits likely to flow from supplementary feeding could include increased wool growth, improved tensile strength, better body reserves during pregnancy leading to life time improvement in progeny performance, better parasite resistance and resilience, and possibly less lamb mortality.

Although not covered in this paper, good nutritional management prior to lambing is essential in order to capture the benefits of higher ovulation rates at joining. There are 2 ways in which nutrition prior to lambing can have a significant impact on lamb survival. The condition score of the ewe is critical and in animals with scores of less than 2, lamb mortality can be around 40% (McClymont and Lambourne 1958). Good nutrition immediately prior to lambing can assist in providing the required hormonal environment for the peri-parturient ewe (Holst *et al.* 2002) as well as increasing colostrum production for the new-born lamb. It is likely that strategic nutritional management based on the requirements of individual ewes prior to lambing will have similar benefits as those described in the current study.

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