Potential Economic Benefits from Improving Ewe Nutrition to Optimise Lifetime Wool Production and Quality in South-west Victoria

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Summary

The amount and quality of wool produced by progeny during their lifetime are influenced by ewe nutrition during pregnancy and lactation. Experimental evidence strongly suggests that better-fed ewes will produce progeny that will produce more wool and finer wool throughout their lives. The potential costs and benefits of managing ewe nutrition through pregnancy in south-west Victoria were modelled using a version of the computer program MIDAS. Based on the assumptions used, improving ewe nutrition during pregnancy by reducing stocking rates and/or increasing the amounts of supplement fed increased farm profitability by up to $28.70 and $38.95/ha/yr for "Early" and "Late" lambing flocks, respectively. These equate to $5.80 and $6.65/ewe/yr respectively. More than 80% of the increase in profit from feeding ewes more during pregnancy was achieved from the progeny producing more wool and especially finer wool rather than from increases in weaning percentage (13%) or extra and broader wool from the ewes (3%).

The analysis indicated that the effects on farm profitability of improving ewe nutrition during pregnancy in this environment are potentially very large, and the formulation of cost-effective feeding strategies for breeding ewes needs to consider the effects on the production and quality of wool produced during the life of their progeny. The analysis highlighted the sensitivity of profit to the size of the progeny wool-production response to ewe nutrition during pregnancy and the importance of relatively small changes in progeny fibre diameter on farm profitability.

Introduction

Seasonal fluctuations in the quantity and quality of pasture available to the grazing sheep are a feature of most wool-producing regions across southern Australia, and most breeding Merino ewes lose weight at some stage during pregnancy (Kelly 1992). Loss of maternal liveweight during pregnancy is normally associated with decreased clean fleece weight and staple strength (Masters *et al*. 1993), lower lamb birth weight and survival (Hinch *et al.* 1985) and permanent changes to the wool-follicle population in the foetus (Schinkel and Short 1961). These changes in the follicle population are expected to influence the amount and quality of wool produced during the lifetime of the progeny, similar to the differences observed between single- and twin-born animals (Lewer *et al.* 1992).

However, only recently has the effects of ewe nutrition *per se* on subsequent lifetime performance been accurately quantified (Kelly *et al.* 1996). In this work, the lifetime productivity of cloned animals created by splitting embryos at day 6 of pregnancy and placing them into ewes fed at different levels through pregnancy was measured. In comparison to progeny from single-bearing ewes fed to maintain maternal liveweight at condition score 3.5, the genetically identical progeny from ewes fed to lose a condition score between days 50 and 140 of pregnancy produced about 0.14kg less clean wool that was also about 0.1µm broader at their hogget shearing (Kelly *et al.* 1996). The effects on progeny performance were evident at each shearing up until 6.5 years of age and were even greater when the ewes were also underfed during lactation (J.C. Greeff, pers. comm.).

The analysis presented in this paper aimed to determine the likely economic impact of managing ewe nutrition during pregnancy for the south-west region in Victoria and then draw some conclusions on the value and priorities for research in the area of ewe nutrition and lifetime wool production and quality.

Materials and Methods

The Great Southern version of the MIDAS models (Young 1995) was modified to represent the region near Balmoral in south-west Victoria, as described in more detail by Thompson and Young (2002). For this analysis, a traditional fine-wool Merino flock (45kg standard reference liveweight, 3.2kg clean fleece weight, 19.6µm mean fibre diameter and 75% weaning rate) that lambed either in late April ("Early") or early September ("Late") was modelled. The wool prices used in this analysis were based on historical data from 1988 to 2000

(G. Lean, pers. comm.); the price used was the median price for 21µm and the median premium for fine wool (the resulting price was 880c/kg clean sweep the board for the flock). The standard cast-for-age ewe price was $15/hd, and the adult wether price was $25/hd. The optimum farm system was calculated for each lambing time, including such parameters as stocking rate, level of supplementary feeding and flock structure, and this became the "standard" model.

The first part of the analysis quantified the costs of providing better nutrition to the ewes, either by reducing the stocking rate and or by increasing the amount of supplement fed. The costs calculated are the net of the increase in income achieved from (1) the ewes producing more wool that was slightly broader and (2) increased lamb survival. Lamb birth weight and survival were predicted from equations relating these traits to ewe liveweight and liveweight change during pregnancy (Kelly 1992*)*. For the "Early" lambing flock, the "standard" level of maternal liveweight loss from day 50 of pregnancy until lambing was 5.1kg; and for the "improved" nutrition treatment, the liveweight loss was reduced to 0.7kg. For the "Late" lambing flock, the ewes gained 0.9kg and 7.3kg maternal liveweight during pregnancy for the "standard" and "improved" nutritional treatments.

The second part of the analysis quantified the changes in production and extra income received from improved production of progeny in response to providing better nutrition to the ewes during pregnancy. The extra income was derived from (1) the progeny producing more wool and (2) the progeny producing finer wool. The assumed effects of ewe nutrition on the wool production and quality of progeny were based on data of Kelly *et al.* (1996). However, the changes in maternal ewe liveweights during pregnancy were less than in that study to allow for the smaller genotype of sheep being modelled (45 versus 65kg), and the response in progeny clean fleece weight and fibre diameter to differences in ewe nutrition was assumed to be linear over the range of ewe liveweight change scenarios examined. The sensitivity of profit to the size of the wool-production responses of the progeny to improving ewe nutrition during pregnancy were determined by assuming the gains in progeny performance were either similar to or double that estimated from a preliminary analysis of data from the study reported by Kelly *et al.* (1996) (Table 1); hereafter referred to as "Single" and "Double" benefit scenarios.

Table 1. Summary of assumed changes in the performance of progeny for "Single" and "Double" benefit scenarios at lamb, hogget and adult shearing resulting from better ewe nutrition during pregnancy.

Sheep age group	Clean fleece weight (kg) Benefit scenario "Single"[1]	Clean fleece weight (kg) Benefit scenario "Double"	Mean fibre diameter (µm) Benefit scenario "Single"[1]	Mean fibre diameter (µm) Benefit scenario "Double"
Lamb	+ 0.10	+ 0.20	0.00	0.00
Hogget	+ 0.14	+ 0.28	– 0.10	– 0.20
Adult	+ 0.10	+ 0.20	– 0.10	–0.20

[1] Values for lamb and hogget wool for "Single" benefit scenario are from Kelly *et al*. (1996).

Results

The key management variables and levels of production achieved from "Early" and "Late" lambing flocks with ewes following the "standard" (i.e., low) liveweight pattern are shown in Table 2. As expected, the optimum stocking rate was higher for the later lambing flock, resulting in more wool being produced per hectare. Time of lambing did not influence the optimum flock structure, and wethers from both systems were sold for live export at 3.5 years of age.

Table 2. Management variables and wool production for "Early" and "Late" lambing flocks with ewes following the low ("standard") liveweight pattern.

Time of lambing	Stocking rate (dse/ha)	Supplementary feed (kg/dse)	Flock structure (% ewes)	Clean wool production (kg/ha)	Clean wool production (µm)	Clean wool production ($/ha)
"Early"	13.3	23	52	44	19.3	388
"Late"	15.5	16	52	49	19.4	440

The cost of improving the nutrition of ewes during pregnancy was higher for "Early" lambing ewes than for "Late" lambing ewes (Table 3). This is because the "Late" lambing ewes were pregnant during winter/spring when high-quality green feed is relatively abundant whereas "Early" lambing ewes were pregnant through summer/autumn when low feed quality is a major constraint to productivity. It was least expensive to provide the extra feed to the "Early" lambing ewes by feeding more supplements whereas, for the "Late" lambing ewes, reducing the stocking rate was least expensive (Table 3).

Table 3. Net costs and source of the extra feed to improve the nutrition of ewes during pregnancy for "Early" and "Late" lambing systems.

Time of lambing	Cost ($/ha)	Cost ($/ewe)	Change in stocking rate (dse/ha)	Change in supplementary feed (kg/ewe)
"Early"	18.30	3.70	0.0	+18.2
"Late"	15.05	2.55	–1.2	–2.9

The increase in income from feeding ewes more during pregnancy was mainly achieved from the productivity increases in the progeny rather than from increases in weaning percentage or the extra wool from ewes (Table 4). This was because the increase in the weaning percentage was small (75% versus 73%) and the extra wool from the ewes was of lower value because it was broader (815 versus 900c/kg clean). Approximately 70% of the benefits achieved from having more-productive progeny was due to the progeny producing finer wool and 30% was from them producing more wool (Table 4).

Table 4. The contribution of each source of extra income toward the total productivity gains achieved from improving ewe nutrition during pregnancy by the "Late" lambing flock ("Single" benefit scenario).

Source	Productivity gains ($/ewe)	Productivity gains (%)
Extra production from ewes		
Extra wool from ewes	0.15	3
Better lamb survival	0.80	13
Total	0.95	16
Extra production from progeny		
More wool from progeny	1.20	20
Finer wool from progeny	3.10	51
Interaction between finer and more wool	0.80	13
Total	5.10	84

The benefits per ewe from having more-productive progeny were similar for each lambing system (Table 5). However, the benefits per hectare or farm of having more-productive progeny were greater for the "Late" lambing flock due to higher stocking rates and therefore more progeny than the "Early" lambing flock. Improving ewe nutrition during pregnancy was worthwhile regardless of time of lambing. If the benefits in progeny performance are similar to those estimated from a preliminary analysis of data from the study reported by Kelly *et al.* (1996) and if they remain throughout the life of the progeny, then increases in profitability of $7.40 and $15.20/ha/yr should be achieved for "Early" and "Late" lambing flocks respectively. If the benefits in progeny performance are double that reported by Kelly *et al.* (1996), then increases in farm profitability of $29/ha and $39/ha per year should be achieved for "Early" and "Late" lambing flocks, respectively.

Table 5. Increase in income due to more-productive progeny for two levels of gain in progeny performance in response to improving ewe nutrition during pregnancy for "Early" and "Late" lambing systems. Values in brackets represent changes in farm profitability.

Benefit scenario	"Early" ($/ha)	"Early" ($/ewe)	"Late" ($/ha)	"Late" ($/ewe)
"Single"	25.70 (7.40)	5.20 (1.50)	30.25 (15.20)	5.10 (2.55)
"Double"	47.30 (29.00)	9.50 (5.80)	54.05 (39.00)	9.20 (6.65)

Discussion

The perceived costs of maintaining ewe liveweights and condition during the autumn/winter fed-gap when most ewes are pregnant means that ewes on commercial properties often lose 0.5 to 1.5 of a condition score by mid-pregnancy or lambing (Kelly 1992). Our analysis of the "whole-farm" implications of this strategy suggests that considerable scope exists for wool producers in south-west Victoria to increase farm profitability by improving ewe nutrition during pregnancy. The economic benefits would be greater for enterprises already running higher stocking rates and producing finer wool but are likely to be less for environments with a shorter pasture-growing season where the costs of supplementary feeding to "improve" ewe nutrition at different times during pregnancy would be greater.

The increase in profit from feeding ewes more during pregnancy was achieved mainly from the progeny producing finer and, to a lesser extent, more wool rather than from increases in weaning percentage and the extra but broader wool from the ewes. The benefits in the performance of progeny in response to improved ewe nutrition could also be larger than the "Single" scenario assumed in this analysis. A recent analysis of the complete data set from the experiment reported by Kelly *et al*. (1996) indicates that the negative effects of poor ewe nutrition on the fibre diameter of progeny wool in particular are much greater than that assumed for the "Single" benefit scenario in this analysis (–0.22 versus –0.10µm in hogget wool and –0.17 versus 0.10µm in adult wool, after adjusting for differences in mean fibre diameter between studies; J.C. Greeff, pers. comm.). Furthermore, the ewes in the study reported by Kelly *et al.* (1996) were in condition score 3.5 at mating; and placental development for such ewes may actually benefit from some loss of maternal liveweight during pregnancy (reviewed by Robinson *et al*. 1999); and the effects on progeny performance were detected despite mean birth weights of 5.0 and 5.5kg for the two feeding treatments. Kelly *et al.* (1996) also used single-bearing ewes, and poor ewe nutrition during pregnancy may have a greater effect on the development and subsequent birth weight of twin-born than single-born lambs (Smeaton *et al.* 1999). We therefore suggest that the effects on progeny performance could be closer to the "Double" benefit scenario assumption in this analysis.

Wool producers across Australia need practical advice that will enable them to increase profitability by balancing the potential benefits from increasing stocking rates to produce more and possibly finer wool per hectare from the ewe flock and the potential penalties in lambing rates, lamb survival and progeny lifetime wool production and quality. Our analysis suggests that more than 50% of the total benefit from improving nutrition during pregnancy was attributable to the progeny producing wool that was just 0.1 to 0.2µm finer at each shearing during their lifetime. Most studies to date have not been able to accurately quantify such small changes in fleece characteristics of the progeny in response to difference in maternal nutrition and have only considered extreme nutritional regimes often outside the boundaries of commercial reality. To our knowledge, there is also no information available describing the effects of different levels of pasture during pregnancy and lactation on the lifetime wool production of the ewe and its progeny. We believe that paddock-scale experiments are required to establish response curves relating a wide range of nutritional options to clean fleece weight and fibre diameter for ewes and their progeny. A series of response curves would allow the full complexity of possible solutions to be modelled for different environments, wool production systems and market conditions.

The Lifetime Wool Production project is a new initiative that aims to determine when and by how much nutrition should be improved during pregnancy to optimise the production and quality of wool from breeding ewes and their progeny during their lifetime. The experiment is being conducted simultaneously at sites located on specialist wool-producing properties near Coleraine in south-west Victoria and near Kendenup in the Great Southern Region of Western Australia. The pasture base at the Victorian site is phalaris/perennial ryegrass and subterranean clover and at the Western Australian site is annual ryegrass and subterranean clover. At each site, a factorial design includes replicates for each of the following 10 treatments: (1) two ewe condition scores (2.0^- and 3.0^+) at day 90 of pregnancy after being joined in condition score 3.0 and (2) five target amounts of feed on offer (800, 1,100, 1,400, 2,000 and > 3,000kg DM/ha) from around day 90 of pregnancy until lamb weaning. Full pedigree information and genetic linkage (> 40%) between sites and across years will allow the data to be pooled. This will significantly improve the capacity of the project to detect the differences between ewe nutritional treatments in progeny clean fleece weight and mean fibre diameter that we have shown in the current analysis to be economically significant. The experiment will be repeated over 3 consecutive years (2001 to 2003), and the first group of progeny ($n \approx 900$) will be shorn as hoggets in summer/autumn 2003.

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