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Perspectives on Merino Wool Producers' Problems in Satisfying Processors' Raw Material Specifications

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SYNOPSIS

From a producer's viewpoint the increased effort and costs associated with implementing a management programme to improve wool quality is only justified when rewarded by an increase in financial returns. Selection of the most profitable strategy for improving raw wool characteristics is complicated by interactions which occur between production and financial variables. These range from conflicts in the response of individual fleece characteristics to changes in management, to conflicts between the different sources of financial returns. There also can be substantial delays between the implementation of a strategy and the resultant increase in financial returns which acts as a disincentive to adoption. With the conflicting responses reducing the net effect of the changes in management, increased financial returns are not guaranteed. This paper first describes procedures developed to predict the effect of farm management strategies on raw wool characteristics. It then discusses the general nature of these interactions in order to illustrate the types of problems which wool producers face in satisfying processors' raw material specifications.

INTRODUCTION

The wool marketing system provides the financial signals which influence the selection of farm management strategies (FMS) and these signals are becoming more clearly defined with the development of wool metrology. The move to sale-by-description presents opportunities for farm managers to adapt traditional practices in order to take advantage of premiums for particular wool characteristics. There are many trade-offs to consider when choosing the best FMS and the challenge is to select one which maximises the chances of gaining financial premiums for particular characteristics while minimising the chance of incurring penalties for other components of the fleece. This requires accurate assessment of the level of production and the resultant financial returns.

A model of a self-replacing flock of Merino ewes has been developed for comparing different FMS under a variety of seasonal and market conditions. This model has been used recently to determine the economics of a number of major FMS designed to improve the productivity of a wool producing enterprise[2,3,4]. In these studies, the model proved to be an effective tool for evaluating systems where there were conflicting demands on the available resources to achieve the production improvement. The information provided by the model on the FMS under a wide range of seasonal conditions was also invaluable given the impact of climatic variations on extensive grazing enterprises in Australia.

The most recent study[5] was designed to evaluate FMS for improving the characteristics of Merino wool. The model was extended to include procedures for predicting the characteristics of raw wool measured objectively under the present marketing system of sale-by-sample. The main objective was to assess the effects of the FMS on farm costs and returns under a variety of seasonal and market conditions, to provide recommendations to producers on the relative merits of available options.

The mathematical relationships used to predict the fibre diameter, staple length and staple strength of Merino wool are first described. These form the basis of predictions of the effects of FMS on fleece characteristics. The remaining

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sections discuss the types of problems that producers can experience in developing FMS for improving raw wool characteristics.

PROCEDURES FOR PREDICTING THE CHARACTERISTICS OF MERINO WOOL

Fibre diameter and staple length

Data gathered to date[6,7,8,9] suggest that an individual sheep grazing pasture can be expected to maintain a relatively constant relationship between staple length (L) and fibre diameter (D) over a range of conditions. Substantial variations in the slope of the relationship have been found between sheep[7] and the slope can change according to whether wool growth rate is increasing or decreasing'. Departures from the relationship have been observed in pen feeding experiments where protein or amino acids have been infused into the abomasum[10]. Short term departures have also been observed where increased shearing frequency caused a disproportionate change in length growth rate[11]. However, the relationship should be appropriate for most on-farm situations in southern Australia where income is determined by the characteristics of wool produced over a full 12 month period. In the model it was assumed that the length growth rate of the fibre was proportional to its cross-sectional area. The equations employed to predict the fibre dimensions from wool growth rate (W) and change in wool growth rate (ΔW) were of the following form, based on the analysis of Bowman[5]

$$D = a + bW^{1/4} + c\Delta W$$

$$L = o + pW^{1/2} + q\Delta W$$

where the coefficients are inputs to the model and reflect genetically determined characteristics of the wool produced.

Staple strength

From a consideration of the mechanical properties of wool it has been demonstrated[12,13] that increases in the variability of cross-sectional area along wool fibres are associated with decreases in strength. In a pen feeding experiment[14] in which sheep were fed at either constant or variable levels of nutrition, a strong negative correlation was observed between staple strength and the variability of diameter along the fibre. Further support is provided by an experiment[15] in which superfine Merinos were housed and fed on constant maintenance rations. Even though the sheep produced very fine wool (17.5 μm), staple strength was far superior to that typical of sheep grazing at pasture.

In the model it was assumed that the intrinsic strength (tenacity) of wool fibres produced by an individual healthy sheep was constant (Gourdie and Ross, unpublished data) and that the maximum staple strength (SSMAX; N $ktex^{-1}$) which could be achieved was a function of the breaking load per unit cross-sectional area (TENACITY; N μm^{-2}) of the fibres. The coefficient of variation of the cross-sectional area (CSACV) along the length of the fibres was used to predict staple strength (SS; N $ktex^{-1}$) as follows:

$$SS = SSMAX - a*CSACV,$$

$$\text{where } SSMAX = b*TENACITY$$

Vegetable Matter

There appears to be little published data on which to base the development of a procedure for predicting changes in the amount of vegetable matter (VM) in wool. In Western Australia, research has centred on the effect of time of shearing on levels of VM[16,17] with shearing in autumn leading to higher levels of VM in the wool than shearing in spring. Sheep husbandry, pasture type and weed control are also known to influence VM levels[18].

Since the degree of VM contamination is likely to be strongly influenced by the individual characteristics of each farm and the nature and timing of specific strategies adopted by the farm manager, no attempt was made to predict changes in VM levels. Instead, auction data collected by the Australian Wool Corporation were examined in order to determine the incidence and nature of VM contamination in southern Australia.

The trends in these data matched the results of the Western Australian research. Shearing in spring ensured that the fleece was short during the period when pasture seeds were most prevalent. Conversely, sheep shorn in autumn had a relatively long fleece in late spring and summer and a much greater proportion of their wool was downgraded because of seed or shive contamination. The data also suggest that VM levels in finer wool were more sensitive to time of shearing than was the case for coarser wool.

The average price received for wool with less than 1% VM was used as the basis for estimating the average discount in price associated with variations in level of contamination for each month of sale for a range of diameters. These discounts were used to correct the prevailing market price according to the level of VM contamination predicted from the diameter and month of shearing.

CONFLICTS OF INTEREST IN MEETING RAW MATERIAL SPECIFICATIONS

Selection of the most profitable FMS for improving raw wool characteristics is complicated by a number of interactions which can occur between production and financial variables. These interactions range from conflicts in the response of individual fleece characteristics to changes in management, to conflicts between the different sources of financial returns. There also can be substantial delays between the implementation of a FMS and the resultant increase in financial returns which acts as a disincentive to adoption.

From a broad industry perspective the implementation of FMS which are effective in meeting the raw wool specifications of wool processors should have high priority. However, from the farm manager's point of view, it is easier to justify the increased effort and costs associated with implementing a FMS to improve wool quality when rewarded by an increase in financial returns. With conflicting responses reducing the net effect of the changes in management, increased financial returns are by no means a certainty. In the following sections the general nature of these interactions are discussed in order to illustrate the types of problems which wool producers face.

Interactions between individual fleece characteristics

Many of the FMS that are designed to increase staple length, staple strength and fleece weight also lead to an increase in fibre diameter. For example, in the experiment of Brown[19], increases in greasy fleece weight from 4.9 to 6.3 kg and staple length from 88 to 101 mm were associated with an increase in fibre diameter from 21.5 to 23.9 µm. Given the sensitivity of price to changes in the diameter of Merino wool, the negative effect of increasing diameter on price would, at the very least, dampen any financial responses to the strategies.

Table I provides an example of the relative importance of fibre diameter, staple length, staple strength and VM as determinants of price. Substantial changes in staple length, staple strength and VM levels are required to produce a change in price equivalent to that for a 1 µm change in fibre diameter. For example, more than a twofold increase in staple strength was required to produce the same change in price as a reduction in mean fibre diameter from 22 to 21 mm

Under the sale-by-sample marketing system, fibre diameter is easily the most important characteristic determining the price of Merino wool, contributing between 80 and 90% of the variation in clean wool price[20]. Studies by Bell[21,22] suggest that fibre diameter is likely to retain its dominant position for the foreseeable future. Strategies designed to improve staple length and strength therefore need to achieve either a substantial change in the characteristics per unit cost or be capable of implementation without unduly affecting mean fibre diameter.

Table I. The change in individual fleece characteristics required to produce the same change in wool price.

Characteristics	Average value[a]	Equivalent changes in the characteristics[b]
Fibre diam (µm)	21.5	22 - 21
Staple lgth (mm)	85	65 - 105
Staple stgth (N ktex^{-1})	38	22 - 54
Veg matter (%)	1.5	5.1 - 0.5

[a] Value taken by the characteristic when another is being varied.
[b] Changes in the characteristics producing the same change in price, calculated using the AWC 1988/89 reserve price schedule.

Interactions between components of wool returns

Variations in gross returns from wool can arise due to changes in fleece weight, wool price and the number of sheep shorn. Often an increase in one of these can be associated with a decrease in one or both of the others. Such interactions can substantially reduce the financial benefits of FMS designed to improve raw wool characteristics.

The model predictions of the effects of stocking rate on wool production and returns provide a good example of this type of problem. Even relatively small changes in stocking rate were found to result in significant reductions in fleece weight, mean fibre diameter, staple length, staple strength and predicted hauteur. However, with more sheep shorn at the higher stocking rates, the total weight of clean wool produced by the flock was substantially increased. The price was not significantly altered by the change in wool characteristics; the effect of the decrease in fibre diameter being sufficient to counter the changes in length and strength. The financial returns from wool were greater at higher stocking rates as a direct result of the greater number of sheep shorn.

This interaction between production per animal and production per unit area of land is well documented[23]. With no net effect being exerted on price by the changes in wool characteristics, the effect of stock numbers on production per hectare easily outweighs the decline in production per animal. Unless there is a substantial readjustment in the relative value of length and strength, a farm manager is not justified in taking action to reduce the decline in predicted hauteur caused by an increase in stocking rate.

Interactions between different sources of farm income

Although wool is the major source of income for a wool-producing enterprise, a substantial proportion of the total income is also derived from the sale of surplus sheep. Attempts to improve these sales can have a negative impact on fleece weight and wool characteristics. For some management strategies the increase from livestock sales can be sufficient to override the deleterious changes in wool characteristics. For example, the model predicted that increasing the reproduction rate of a Merino flock would lead to a significant reduction in average fleece weight, staple length and staple strength. However, the greater number of progeny shorn and sold in flocks with more prolific ewes easily compensated for the reduction in fleece weight, staple length and strength.

Lags in response to changes in management

The FMS discussed above involve changing the feed supplied to the animal. Producers can also consider genetically improving the wool characteristics of a flock, however the same interactions between fleece characteristics occur[24].

When a number of wool characteristics determine the financial returns from a flock the most efficient method of selection is index selection[25] which accounts for interactions between fleece characteristics, for example, fleece weight and fibre diameter. The relative financial values of each characteristic are needed but are difficult to estimate as wool prices fluctuate markedly[26]. Another problem is created by the lag in time between choosing replacement hoggets and the marketing of their wool and that of future offspring.

The predicted time taken to reduce average flock fibre diameter by 1 µm when selection indices are used is 7-12 years depending on the economic values used[27]. When an index is reset annually in response to fluctuating prices this change may never be achieved due to continual change in relative economic values.

The producer thus has a difficult task when deciding on the direction of selection. This task is made easier if market signals are stable and well defined. An immediate response to a changed market is only possible by buying, not breeding stock.

GENERAL DISCUSSION

The quality of wool produced is but one of many production variables which a producer needs to consider when choosing a profitable FMS. The relative economic values of the different components of production are such that increases in farm income are possible even when the FMS result in a reduction in wool quality. This is often the case where the quantity of wool produced is increased at the expense of wool quality.

The conflicts which occur clearly limit the range of options available to producers for improving raw wool characteristics. The uncertainty as to the price to be realised for individual sale lots and problems in forecasting longer term trends in price further complicate the task. Delays between the time of implementation of a FMS and the resultant improvement in financial returns can also act as a disincentive to adoption. For the foreseeable future, Merino wool producers are likely to continue to place emphasis on fleece weight and fibre diameter when choosing management strategies. This is unlikely to change until premiums/discounts for other characteristics of raw wool are substantially increased.

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REFERENCES

1. White, D.H., Bowman, P.J., Morley, F.H.W., McManus, W.R. and Filan, S.J. (1983). A simulation model of a breeding ewe flock. Agric. Systems *10*: 149-189.

2. Bowman, P.J., Fowler, D.G., Wysel, D.A. and White, D.H. (1989). Evaluation of a new technology when applied to sheep production systems. II. Real time ultrasonic scanning of ewes in mid-pregnancy. Agric. Systems *29:* 287-323.

3. White, D.H. (1984). Economic values of changing reproduction rates. In Reproduction in sheep. (Eds. D.R. Lindsay and D.T. Pearce) pp. 371-377. Australian Academy of Science, Canberra.

4. White, D.H. and Bowman, P.J. (1987). Economics of feeding energy-based supplements to grazihg ewes before mating in order to increase the reproduction rate of a wool producing flock. Aust. J. Exp. Agric. *27*: 11-17.

5. Bowman, P. J. (1989) . Farm management strategies for improving the quality of fine wool. Ph.D. Thesis, Lincoln College, Canterbury, New Zealand.

6. Arnold, G.W. and McManus, W.R. (1960). The effect of level of stocking on two pasture types upon wool production and quality. Proc. Aust. Soc. Anim. Prod. *3*: 63-68.

7. Cottle, D.J. (1987). Fleece weight: fibre diameter ratios and sheep selection. Wool Tech. Sheep Breed. *35*: 186-189.

8. McManus, W.R., Arnold, G.W. and Paynter, J.R. (1964) . Studies in the wool production of grazing sheep. 2. Variation in wool characteristics with season and stocking rate. Aust. J. Exp. Agric. Anim. Husb. *4*: 404-411.

9. Purser, D.B. (1981). Nutritional value of Mediterranean pastures. In Grazing animals. (Ed. F.H.W. Morley) pp. 159-180. Elsevier, Amsterdam.

10. Allden, W.G. (1979). Feed intake, diet composition and wool growth. In Physiological and environmental limitations to wool growth. (Eds. J.L. Black and P.J. Reis) pp. 61-78. University of New England Publishing Unit, Armidale, Australia.

11. Bottomley, G.A. (1979). Weather conditions and wool growth. In Physiological and environmontal limitations to wool growth. (Eds. J.L. Black and P.J. Reis) pp. 115-126. University of New England Publishing Unit, Armidale, Australia.

12 . de Jong, S ., Kavanagh, W.J. and Andrews, M.W. (1985) . Factors contributing to the staple strength of wool. Proc. 7th Int. Wool Text. Res. Conf. *2*: 147-156.

13. Collins, J.D. and Chaikin, M. (1968). Structural and non-structural effects in the observed stress-strain curve of wet wool fibres. Text. Res. J. *35*: 777-787.

14 . Hansford, K.A. and Kennedy, J. P . (1988) . Relationship between the rate of change in fibre diameter and staple strength. Proc. Aust. Soc. Anim. Prod. *17*: 415.

15. Cottle, D.J. (1986). Wool properties of housed superfine Merino wethers fed grain, lucerne chaff and mixed rations. Wool Tech. Sheep Breed. *34*: 132-137.

16. Arnold, G.W. and Gordon, I.D. (1973). An assessment of seasonal changes in wool quality in agricultural areas of Western Australia. J. Aust. Inst. Agric. Sci. *13*: 151-153.

17. Arnold, G.W., Charlick, A.J. and Eley, J.R. (1984) . Effects of shearing time and lambing on wool growth and processing characteristics . Aust . J. Exp. Agric. Anim. Husb. *24*: 337-343 .

18. Lunney, H.W.M. (1983). Vegetable fault in Australian wool: classification, consequences and economic loss. J. Aust. Inst. Agric. Sci. *49*: 207-211.

19. Brown. T.H. (1976). The effect of stocking rate and deferred autumn grazing of pasture on liveweight and wool production of Merino wethers in a Mediterranean-type climate. Aust. J. Exp. Agric. Anim. Husb. *16*: 189-196.

20. Pattinson, R.D. (1981). What characters determine the clean price of wool at auction. Wool Tech. Sheep Breed. *29*: 93-98.

21. Bell, P.J.M. (1984). Economic implications of extra measurements. Wool Tech. Sheep Breed. *32*: 56-58.

22. Bell, P.J.M. (1987). Topmaking today. Wool Tech. Sheep Breed. *35*: 101-108.

23. White, D.H. (1987). Stocking rate. In Managed grasslands: Analytical Studies. (Ed. R.W. Snaydon) pp. 227-238. Ecosystems of the World, Vol. 17B, Elsevier, Amsterdam.

24. Mortimer, S. (1987). Australian estimates of genetic parameters for wool production and quality traits. In Merino improvement programs in Australia. (Ed. B.J. McGuirk) pp. 457-480. Australian Wool Corporation, Melbourne, Australia.

25. Cottle, D.J. and Maddever, D.C. (1988). Optimisation of returns in sheep breeding programs based on objective measurement. In Wool Research Organisation of New Zealand special publication Volume 6. (Eds. G.A. Carnaby, E.J. Wood and L. F. Story) pp. 274-283, Wool Research Organisation of New Zealand, Christchurch.

26. Cottle, D.J., Maddever, D.C. and Sanderson, R.H. (1988) . Development of economic values for wool traits using forecasting techniques and vector space analysis of auction data. Proc. Aust. Assoc. Anim. Breed. Genet. *7*: 398-401.

27. Ponzoni, R.W. (1988). Updating of economic values and phenotypic and genetic parameters of WOOLPLAN. Wool Tech. Sheep Breed. *36*: 70-75.