PREDICTED RESPONSE TO MULTIPLE TRAIT SELECTION WHEN CRIMP FREQUENCY IS INCLUDED IN A BREEDING OBJECTIVE FOR MERINO SHEEP

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INTRODUCTION

Crimp frequency (CF) is a greasy wool trait of interest to ram breeders, commercial wool growers and wool processors alike. Early studies of CF effects on processing performance were reviewed by Hunter (1980) and are confirmed by more recent work. In general, low CF wools tend to process more efficiently than higher CF wools of similar mean fibre diameter (MFD) and staple length (SL). For example, low CF wools tend to be more efficient in topmaking (i.e. longer Hauteur and lower Romaine), and can be spun with fewer ends down and produce more even yarns (e.g. Kurdo *et al*., 1986a, b ; Stevens and Crowe, 1994 ; Swan *et al*., 1995 ; Lamb *et al*., 1996 ; Lamb, 2000). CF also affects fabric properties such as thickness, drape, felting and pilling propensity, but the most appropriate CF depends on the characteristics desired of the fabric and the system (worsted or woollen) on which it is produced (e.g. Hunter *et al*., 1982 ; Stevens and Mahar, 1995 ; Wuliji *et al*., 1995). Despite this, or perhaps because of these varying fabric properties, wool buyers and processors appear to have preferences for either high or low CF wools. That is, the economic value of CF may be positive or negative depending upon the buyer or processor.

As a result of these mixed messages in the marketplace and the lack of an appropriate objective measurement method for CF, ram breeders have no estimates of the economic value of CF, and therefore, are unsure of the importance they should attach to CF in their breeding objectives. In this paper we investigate the effects on gains in the breeding objective of varying economic values for CF in Merino breeding programs.

In examining the importance of CF in Merino breeding programs, CF should be considered in a multi-trait breeding objective with the outcomes from the selection strategy modelled from analyses using genetic parameters appropriate to the type of sheep. The phenotypic and genetic parameters, and economic values of the breeding objective traits (other than CF) used in this study were previously estimated from the CSIRO Fine Wool Project (FWP) flock.

MATERIALS AND METHODS

Parameter estimates. Phenotypic and genetic parameters used for this study have been derived from a consolidation of previous studies of the CSIRO FWP flock (Purvis and Swan, 1997 ; Smith *et al*., 2001 ; Swan *et al*., 1997), although certain assumptions were made where precise estimates were unavailable.

Economic values. Relative economic values for clean fleece weight (CFW), staple strength (SS) and MFD are those routinely used in SelectGene breeding value predictions for fine wool sheep (A. Swan *pers. comm*.). Because we have no firm basis to estimate the economic value of CF, values over a range from –20 to +20 % for CF price premium were examined.

Response to selection. Response to selection is predicted using the software package SelectGene (Swan *et al*., 2000). The effect of different price premiums for CF is examined under two selection indices that reflect objectives where moderate and high emphasis is placed on decreasing MFD and maintaining SS while increasing CFW. Firstly, the price premiums for MFD and SS are 8 % and 2 % respectively; and secondly the price premiums for MFD and SS are 20 % and 4 % respectively. Response to selection was also estimated where CF was included in the breeding objective, but not as a selection criterion.

RESULTS AND DISCUSSION

Figure 1 shows predicted response per year in hogget CFW, MFD and CF for CF economic values ranging from –20 % (i.e. increasing CF results in a price penalty) to +20 % (i.e. increasing CF results in a price premium) for the two selection indices described above. The response to selection is expressed in genetic standard deviation units to enable direct comparison of the trends in CFW, MFD and CF for each index.

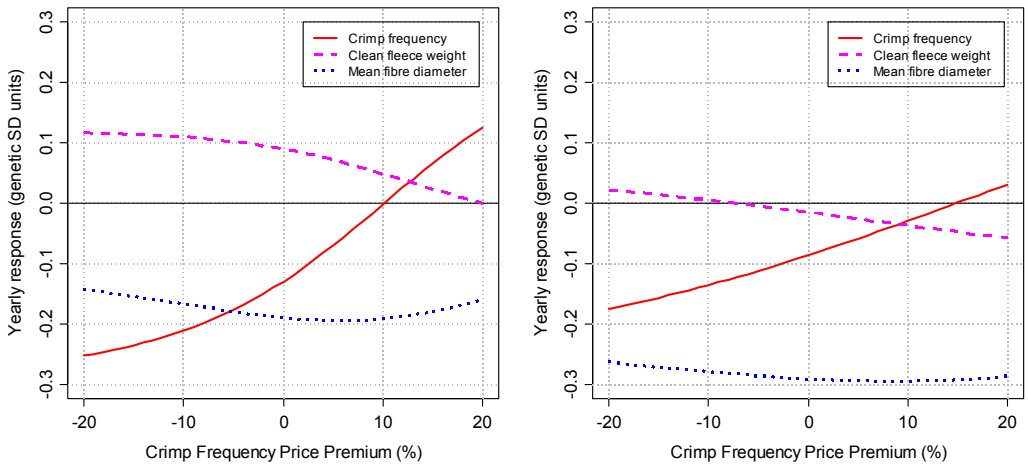

Figure 1. Response to selection under a range of crimp frequency price premiums for two indices where crimp frequency is in the breeding objective and is a selection criterion
a) MFD premium=8%, SS premium=2% b) MFD premium=20%, SS premium=4%

Premium for low CF. The potential for genetic change in CF is greatest when there is relatively less selection pressure on MFD (*i.e*. lower MFD price premium) and when the price premium for CF is negative (*i.e*. decreasing CF attracts a price premium). Under both of the indices examined here, but more so using the lower (8 %) MFD premium index, we would expect to see little, if any effect on response in CFW, and perhaps a small increase in the rate of response in MFD if the price premium for CF is negative.

Premium for high CF. If the price premium for CF is positive (i.e. increasing CF attracts price premium), there will be very small adverse effects on the rate of response in CFW and MFD as the price premium for CF increases. These effects are most evident under the lower MFD

premium index where there is relatively less selection emphasis on MFD and relatively more selection emphasis on CFW. This is probably because CF is more closely correlated with CFW and SL than MFD. However, for fine wool producers, where much of the selection emphasis is on MFD, adverse consequences for MFD and CFW are minimal unless the price premium for CF exceeds approximately +10 %.
If it were desirable to increase CF, using the high MFD premium index we would not see a positive change in CF until the CF price premium reaches approximately +15 %. That is, if the economic value of CF is positive, it is more difficult to achieve a positive change in CF as the selection emphasis on MFD increases.
If CF is included in the breeding objective but is not among the selection criteria (graphs not shown), there are no major consequences for the rate of genetic gain in any of the traits of interest (namely CFW, MFD, SS and CF). Under either of the selection strategies examined, the rate of response to selection on CF and MFD would change very little regardless of the price premium for CF. However, under the lower MFD premium, rate of response in CFW declines slightly as the price premium for CF increases. Within this range of CF price premiums, CF does not reach a positive value for genetic gain using either selection strategy.

Estimation of CF economic value. Apart from the apparent differences (based on anecdotal evidence) in the value of CF to different wool buyers and processors, there are several other factors that make difficult the task of estimating the economic value of CF. For example, fibre curvature (FC) may be an appropriate objective measurement of CF, but to date, there is only preliminary evidence of a relationship between CF and FC. There is little, if any information in the National Wool Auction Database on FC, and there is no IWTO Standard Test Method for FC. Also, the economic value of CF is likely to be dependent on other economically important traits. For example, CF may be more important in processing wools of lower fibre diameter and better style.
Another challenge in assigning an economic value for CF is the varying importance of CF at different stages of processing. If the wool grower or ram breeder is solely concerned with personal profit, this is not an issue and the breeding objective should be geared toward maximum return at point of sale. However, if the focus of the breeding objective was to produce the best product for downstream clients, then the breeding objective might be slightly different and may require customised objectives for individual breeders. If this were the case, the value of CF would be even more difficult to quantify since different wool buyers appear to prefer certain crimp types and CF may vary in importance at the different stages of processing.

CONCLUSION

Recently the Australian wool industry has seen lively discussion of the pros and cons of breeding for either true to type, high CF versus longer stapled, lower CF fine and superfine wools. In reality, the different wool types may have very definite and specific advantages in processing and this will ensure incentives for the production of both types of wools into the future. It is also likely that marketing, management and geographical considerations of ram breeder clients (*i.e*. commercial wool growers) will focus breeders toward one or other of those markets.
Putting the issue of the actual economic value of CF aside, unless the true economic value of CF is outside the range of values examined here, selection on CF is unlikely to have a major

adverse effect on profitability. However, if the breeding objective is to increase CF, it will be more difficult to concurrently increase CFW, and achieve positive change in CF until the economic value of CF is relatively high. If there is a price premium for either high or low CF wools, it is likely to be relatively small (probably around 5 %) except for the case of specialty (ultrafine) wools for highly specified markets in which case the economic value of certain CF types may be considerably higher.

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