Selection response with index selection in three commercial Merino flocks

D.G. Poggenpoel*
Faculty of Agricultural Sciences, University of Stellenbosch, Stellenbosch, 7600 Republic of South Africa
C.A. van der Merwe
Merino Stud Breeders Association, P.O. Box 109, Graaff-Reinet, 6280 Republic of South Africa

Received 24 July 1986

Members of the Performance Testing Division of the Merino Stud Breeders Association of South Africa select their young sheep according to a selection index, calculated from objective measurements of the following four characteristics body mass, clean fleece mass, fibre diameter and fold score. The average relative weighting factors for these four characteristics over the period of this study were 1: 10: -3: -3 respectively. Breeders can also measure the breeding value of their breeding rams against a genetic control flock. This test can be repeated in a particular flock at a later date to estimate breeding value changes over time. Tests were repeated after 7 years of index selection in three commerical flocks. The average percentage changes in breeding values for the different characteristics were as follows: body mass 12,1; greasy fleece mass 9,8; clean yield 3,9; clean fleece mass 14,4; staple length 10,6; crimps per 25 mm -5,3; fibre diameter -1,7; fold score -29,4. The responses obtained in the selected characteristics were in agreement with theoretical predictions.

Lede van die Prestasietoets-afdeling van die Merinostoettelersgenootskap van Suid-Afrika selekteer hul jong skape met behulp van 'n seleksie-indeks wat bereken word vanaf objektiewe metings van die volgende vier kenmerke, liggaamsmassa, skoonwolmassa, veseldikte en plooitelling. Die gemiddelde relatiewe wegingsfaktore van hierdie vier kenmerke was respektiewelik 1: 10: -3: -3 vir die periode van hierdie studie. Telers kan ook die teelwaarde van hul teelramme teenoor ramme uit 'n genetiese kontrolekudde meet. So 'n toets kan later herhaal word in 'n betrokke kudde om die verandering in teelwaarde oor 'n periode te bereken. Sulke toetse is na 7 jaar van indeksseleksie in drie geslote kommersiële kuddes herhaal. Die gemiddelde persentasie verandering in teelwaarde was: liggaamsmassa 12,1; rouwolmassa 9,8; skoonopbrengspersentasie 3,9; skoonwolmassa 14,4; stapellengte 10,6; kartels per 25 mm -5,3; veseldikte -1,7; plooitelling -29,4. Hierdie verkreë responsies was in ooreenstemming met die teoretiese voorspelling.

Keywords: Merino sheep, index selection, selection response.

An extract of this paper was published in the Proceedings of the 2nd World Merino Conference, Madrid, 21–23 April 1986, Short Papers 1: 21–28

* To whom correspondence should be addressed

Introduction

There are several experimental Merino flocks which are selected for increased fleece mass. In a comprehensive review by McGuirk (1983) results of five Australian Merino flocks are presented and Rogan (1984) gave further results of one of these flocks. A South African Merino flock was also included in the first review (Heydenrych, Vosloo & Meissenheimer, 1977). Measurements of response in later years for this flock were presented by Heydenrych, du Plessis & Cloete (1984). In some of these flocks selection was solely for increased greasy or clean fleece mass, whilst in others some other traits were also taken into account. The average response in fleece mass in these flocks was of the order of 1% per year (McGuirk, 1983). As mentioned by McGuirk (1983) there are, however, no estimates of genetic progress in fleece mass in commercial Merino flocks.

In commercial Merino flocks, fleece mass will be of major economic importance but other traits can also make a contribution to total income. This may include traits like reproduction rate, body mass at some critical stage (Ponzoni, 1982a), fibre diameter because of its important influence on wool price (Whiteley & Jackson, 1982), and probably skin fold score because of its influence on reproduction rate (Dun & Hamilton, 1965; Turner & Young, 1969). Suggestions for exploiting the selection index theory for selection of Merino sheep in Australia were put forward recently by, among others, Ponzoni (1979; 1982b) and Walkley & Ponzoni (1984).

A procedure of selection for commercial Merino sheep in South Africa, by means of selection index, was proposed by Poggenpoel & van der Merwe (1975). The aim was to increase total income per individual. The suggestion was that all young animals should be visually inspected at the age of 15 – 18 months and those with serious defects be culled. The remaining acceptable animals should then be measured for body mass, clean fleece mass, fibre diameter and total skin fold score. Fold score being evaluated according to the photo standards of Turner, Hayman, Riches, Roberts & Wilson (1953). Measurements of these four traits should then be weighed by their respective appropriate weighting factors and combined into a selection index for each individual. Weighting factors were calculated according to the method of Hogsett & Nordskog (1958). Genetic parameters were obtained from a review of mainly Australian literature and phenotypic parameters from South African data. Local market prices were used to calculate the economic value of each trait. In 1972 approximately 12 commercial Merino breeders accepted this method of index selection. This number has grown steadily and at present approximately 70 members of the Performance Testing Division of the Merino Stud Breeders Association of South Africa make use of this system.

To measure differences in breeding value between commercial flocks, a progeny test procedure incorporating the use of rams from the Tygerhoek genetic control flock, was developed. The procedure was explained by van der Merwe & Poggenpoel (1977) together with results of the first three tests. From an investigation by Heydenrych, Vosloo, du Plessis & Meissenheimer (1984) it was concluded that this control flock remained fairly stable over the first 11 years of its existence. For the breeding value determinations, a group of 10 – 12 surplus rams from the Tygerhoek genetic control flock is mated to part of a breeder's breeding ewes while a comparable group of ewes is mated to his own selfbred breeding rams. The two progeny groups are reared together on the breeder's farm and measured at about 18 months of age. Differences between the means of the two progeny groups are expressed as percentages of the estimated expected mean of the control flock on that particular farm. This is essentially a test of the breeding value of the breeder's group of breeding rams. On the assumption of similar selection intensities for rams in different closed flocks, these values for the different participating flocks are compared and referred to as the breeding value of the flock concerned. Results of the first 25 commercial flocks tested were given by Poggenpoel & van der Merwe (1984).

It was also pointed out (van der Merwe & Poggenpoel, 1977) that this control test could be repeated in a particular flock after some years. The change in the breeding value of this flock over this period could then be estimated from the change in its deviation from the control flock.

The results of the first three genetic gain tests by this procedure for South African commercial Merino flocks, are presented in this paper.

Materials and Methods

Closed flock selection was practised in three commercial Merino flocks from the first till the second control test.

Replacement animals were selected according to their selection indices based on measured performance of body mass, clean fleece mass, fibre diameter and skin folds. All animals were shorn as lambs and measured 6 – 12 months later. Breeders sent all their data annually to the Fleece Testing Centre at Grootfontein Agricultural College for processing. Each breeder then received a list with each group of sheep ranked according to their selection indices. A breeder was free to select animals from this ranking list according to his own preferences. During the last part of this period, greasy fleece mass and sometimes crimps per 25 mm instead of clean fleece mass and fibre diameter were measured in ewes.

The original relative weights of the four traits, *viz.* body mass, clean fleece mass, fibre diameter and total skin fold score were estimated at 1: 7: -1: -1 (Poggenpoel & van der Merwe, 1975). These weights were however changed several times over the years to follow market trends. The average weights over the period of this study was of the order of 1: 10: -3: -3 respectively. Where greasy fleece mass and crimps per 25 mm replaced clean fleece mass and fibre diameter in ewe selection, the weighting factors were adapted accordingly.

Because of the extensive nature of farming, measurements of fertility or reproduction rate were not available in these flocks and it was not taken into account with selection. The positive association of body mass with reproduction and the negative association of fold score with reproduction was, however, taken into consideration in the calculation of the weighting factors for these two traits.

The breeding flocks consisted of about five age groups of ewes and about two age groups of rams, giving an approximate generation interval of 3,25 years. About 20% of the numbers measured for rams and 60% for ewes were selected, giving an overall selection intensity of approximately 1 *SD*. In all three flocks no unrelated breeding material was introduced after the first control test. Thus, any genetic change in breeding value can be ascribed to the selection procedure followed.

In the year when a control test was done, lambs were identified according to their sire group but were raised as one flock. No preliminary culling was done and all lambs were available for measurement.

Results and Discussions

The genetic and phenotypic parameters used to calculate the relative weighting factors are presented in Table 1. These values have been slightly adapted from the original paper by Poggenpoel & van der Merwe (1975).

The numbers measured and the percentage deviations from the genetic control flock are given in Table 2. Reasonably large numbers were measured and the number per progeny test group varied from 70 to 1084.

Table 1 Genetic and phenotypic parameters used for the estimation of the weighting factors

	Body mass	Clean fleece	Fibre diameter	Fold score
Heritabilities	0,40	0,40	0,47	0,39
Standard deviations	4,69	0,62	1,34	2,12
Correlations[a]				
Body mass		0,27	0,06	-0,18
		0,40	0,20	-0,10
Clean fleece			0,16	-0,06
			0,20	0,20
Fibre diameter				0,20
				-0,05

[a]Genetic correlations upper figures and phenotypic correlations lower figures

Table 2 The percentage deviations of traits of the three commercial flocks from the control flock

	Number of progeny		Body	Greasy	Clean	Clean	Crimps	Fold	Staple	Fibre	Period
	Farm	Control	mass	fleece	yield	fleece	per 25mm	score	length	diam.	years
Flock 1											
Test 1	128	76	-2,8	12,5	-4,9	6,3	-5,3	36,3	-5,4	7,2	
Test 2	265	70	13,2	7,6	0,7	7,9	-8,5	-31,5	11,0	6,0	5,67
Change			16,0	-4,9	5,6	1,6	-3,2	-67,8	16,4	-1,2	
Flock 2											
Test 1	172	211	1,6	11,6	-0,6	10,9	0,0	32,0	-3,7	2,7	
Test 2	1084	541	12,0	25,3	0,8	26,0	1,3	3,4	4,0	3,5	8,0
Change			10,4	13,7	1,4	15,1	1,3	-28,6	7,7	0,8	
Flock 3											
Test1	244	132	9,6	1,9	-3,4	-1,6	-3,6	-36,7	5,3	5,0	
Test 2	498	196	19,5	22,6	1,2	24,8	-17,6	-28,6	12,9	0,5	6,75
Change			9,9	20,7	4,6	26,4	-14,0	8,1	7,6	-4,5	
Averages											
Test 1	544[a]	419[a]	2,8	8,7	-3,0	5,2	-3,0	10,5	-1,3	5,0	
Test 2	1847[a]	807[a]	14,9	18,5	0,9	19,6	-8,3	-18,9	9,3	3,3	6,8
Change			12,1	9,8	3,9	14,4	-5,3	-29,4	10,6	-1,7	

[a] Total number of animals measured

The average change in breeding value of the traits in the selection index over the period of 6,8 years was: body mass 12,1%; clean fleece mass 14,4%; fibre diameter -1,7% and skin fold score -29,4%. Clean fleece mass showed a favourable response of about 2% per year. Correlated responses were: greasy fleece mass 9,8%; clean yield 3,9%; crimps per 25 mm -5,3% and staple length 10,6%.

Table 2 shows reasonable variation in responses between the three different flocks especially in clean fleece mass and skin fold score. Flock 1 shows a small increase of 1,6% in clean fleece mass and an exceptionally large decrease of 67,8% in fold score. This phenomenon can be explained by the fact that the breeder of flock 1 had a preference for plainer bodied sheep and discarded high ranking animals on selection index which had a relatively high fold score.

With a selection intensity of one standard deviation the expected response per generation, estimated for each of these traits was as follows: body mass 1,23 kg; clean fleece mass 0,21 kg; fibre diameter -0,15 μm and fold score -0,48. The means of these traits in 25 commercial flocks were estimated as: body mass 33 kg; clean fleece mass 3,65; fibre diameter 20,6 μm and fold score 6,5 (Poggenpoel & van der Merwe, 1984). With a generation interval of 3,25 years and a selection intensity of 1 *SD*, the expected responses over the average period of 6,8 years can be estimated. With the expected and observed total response expressed as a proportion of the overall mean, the changes in phenotypic values (expressed as percentages) are estimated as presented in Table 3.

Table 3 The percentage expected and observed selection response in three Merino flocks over a period of 6,8 years

	Body mass	Clean fleece mass	Fibre diam.	Fold score
Expected response	7,8	12,3	-1,5	-15,4
Observed response	12,1	14,4	-1,7	-29,4

The expected and observed values for clean fleece mass and fibre diameter were in close agreement. The observed responses for body mass (positive) and fold score (negative) were more favourable than expected.

It is significant that there was on average a marked decrease in fold score and a simultaneous increase in clean fleece mass. In the Merino industry there is at present a move away from sheep with too many skin folds. As a decrease in fold score leads to a reduction in body surface area, this can cause a decrease in fleece mass. In the present study this expected negative effect was cancelled out partly by an increase in body mass (an increase in body surface area) as well as an increase in staple length. In Australian experiments increased fleece mass was mainly caused by an increase in fibre density (McGuirk, 1983). This characteristic probably also contributed to the results of this study although it was not measured.

A further significant result of the present study was that it was possible to increase clean fleece mass without an increase in fibre diameter. For the commercial farmer this means a higher wool production of the same quality and price. This is in agreement with Australian results (McGuirk, 1983) and results of the Tygerhoek selection flock (Heydenrych, *et al.*, 1984) where special measures were taken to prevent an increase in fibre diameter. Because of the positive genetic correlation between fleece mass and fibre diameter of around 0,16 (McGuirk,

1983) any selection programme designed to maintain fibre diameter will hamper an increase in wool mass.

Although not too much weight can be attached to one or a few results of this kind, because of the limited control over commercial flocks, the average response in these three flocks is encouraging. It can serve as evidence to stimulate the use of objective measurements in the selection of Merino sheep under stud and commercial conditions.

Acknowledgements

The authors wish to thank Dr J.H. Randall for the computer program to estimate the weighting factors and the following Merino breeders for doing the control tests and collecting the data: Messrs S.W.P. van der Merwe, N. Loubser and H. du Toit.

References

DUN, R.B. & HAMILTON, B.A., 1965. Skin folds and Merino breeding. *Aust. J. Exp. Aqric. Anim. Husb.* 5, 236.

HEYDENRYCH, H.J., DU PLESSIS, J.J. & CLOETE, S.W.P., 1984. Increasing the wool production in Merino sheep in the South Western districts of South Africa by direct and indirect selection. *Proc. 2nd World Cong. on Sheep and Beef cattle Breeding* pp.399–412. Eds. Hofmeyr, J.H. & Meyer, E.H.H.

HEYDENRYCH, H.J., VOSLOO, L.P., DU PLESSIS, J.J. & MEISSENHEIMER, D.J.B., 1984. Maintaining genetic stability in a control flock of South African Merino sheep. *S. Afr. J. Anim. Sci.* 14, 34.

HEYDENRYCH, H.J., VOSLOO, L.P. & MEISSENHEIMER, D.J.B., 1977. Selection response in South African Merino sheep selected either for high clean fleece mass or for a wider S/P ratio. *Agroanimalia* 9, 67.

HOGSETT, M.L. & NORDSKOG, A.M., 1958. Genetic-economic value in selecting for egg production rate, body weight and egg weight. *Poult. Sci.* 37, 1404.

McGUIRK, B.J., 1983. Genetic selection for wool production. In: Sheep Production, 546-566. Ed. Haresign, W. Butterworth, London.

POGGENPOEL, D.G. & VAN DER MERWE, C.A., 1975. Die gebruik van seleksie-indekse by Merinoskape. (The use of selection indices for Merino sheep). *S. Afr. J. Anim. Sci.* 5, 249.

POGGENPOEL, D.G. & VAN DER MERWE, C.A., 1984. Breeding value differences between commercial Merino flocks. *Proc. 2nd World Cong. on Sheep and Beef Cattle Breeding* pp. 711-717. Eds. Hofmeyr, J.H. and Meyer, E.H.H.

PONZONI, R.W., 1979. Objectives and selection criteria for Australian Merino Sheep. *Proc. Aust. Assoc. Anim. Breeding and Genetics* 1, 320.

PONZONI, R.W., 1982a. The importance of live weight in the genetic improvement of Australian Merino sheep. *Wool Techn. and Sheep Breeding* 30, 44.

PONZONI, R.W., 1982b. Breeding objectives in sheep improvement programmes. *Proc. 2nd World Cong. Genet. Appl. Livest. Prod.* Madrid, Spain, vol. 5, pp. 619.

ROGAN, I.M., 1984. Selection for wool production. *Proc. 2nd World Cong. on Sheep and Beef Cattle Breeding* pp. 367-380. Eds. Hofmeyr, J.H. & Meyer, E.H.H.

TURNER, HELEN N., HAYMAN, R.N., RICHES, J.H., ROBERTS, N.F. & WILSON, L.T., 1953. Physical definition of sheep and their fleece for breeding and husbandry studies, with particular reference to Merino sheep. *CSIRO Div. Anim. Hlth. Prod. Div. Rept.* No.4.

TURNER, HELEN, N. & YOUNG, S.S.Y., 1969. Quantitative Genetics in Sheep Breeding. New York, Cornell University Press.

VAN DER MERWE, C.A. & POGGENPOEL, D.G., 1977. The practical application of scientific principles in Merio sheep breeding. *S. Afr. J. Anim. Sci.* 7, 71.

WALKLEY, J.R.W. & PONZONI, R.W., 1984. An application of selection index theory to Merino breeding: a case study. *Wool Techn. and Sheep Breeding* 32, 41.

WHITELEY, K.J. & JACKSON, N., 1982. Breeding for apparal wool. *Proc. World Cong. on Sheep and Beef Cattle Breeding*, Nov. 1980, pp. 47-55. Eds. Smith, W.C. & Barton, R.A.