Short Communication

Heritability estimates for merino sheep obtained from a national progeny test

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Data of 5342 progeny from 232 sires from 30 genetically linked flocks, collected through the National Progeny Testing program for Merino sheep from 1991 to 1996, were used to estimate heritabilities for several production and type traits. The traits analysed were: body weight (BW), clean fleece weight (CFW), mean fibre diameter (MFD), staple length (SL), fold (wrinkle) score (FS), wool quality (QUAL), variation crimps per 25 mm (VAR), wool yolk (OIL), staple formation (SF), belly and points (BP), head size (HEAD), colour (COL), fore quarters (FQ), pasterns (PAS), hocks (HOC) and conformation (CON). In most traits the effect of herd-year-season (HYS) was significant ($P \leq 0.01$). For the production traits, excluding MFD, the interaction between HYS and sex was significant. Birth status had no significant ($P \geq 0.05$) effect on QUAL, OIL, SF, COL and PAS. Heritability estimates for the various traits were: 0.34 for BW, 0.23 for CFW, 0.44 for MFD, 0.70 for SL, 0.32 for FS, 0.27 for QUAL, 0.23 for VAR, 0.24 for OIL, 0.09 for SF, 0.17 for BP, 0.35 for HEAD, 0.17 for COL, 0.21 for FQ, 0.12 for PAS, 0.26 for HOC and 0.31 for CON. Standard errors for these estimates ranged from 0.03 to 0.06. It is recommended that these heritability estimates be used in the calculation of selection index weighting factors, as well as EPD's in the National Progeny Testing Scheme.

Data van 5342 nageslagte van 232 vaders in 30 geneties-gekoppelde kuddes, versamel deur middel van die Nasionale Nageslagtoetsprogram vir Merinoskape vanaf 1991 tot 1996, is vir die beraming van oorerflikhede van verskeie produksie- en subjektiewe eienskappe gebruik. Die volgende eienskappe is ontleed: liggaamsgewig (BW), skoonvaggewig (CFW), gemiddelde veseldikte (MFD), stapellengte (SL), plooitelling (PS), wolkwaliteit (QUAL), variasie kartels per 25 mm (VAR), wololie (OIL), stapelformasie (SF), onderlyne (BP), kopgrootte (HEAD), kleur (COL), voorkwarte (FQ), kote (PAS), hakke (HOC) en algemene bouvorm (CON). Die effek van kudde-jaar-seisoen (HYS) was betekenisvol ($P \leq 0.01$) vir die meeste eienskappe. Die interaksie van HYS met geslag was betekenisvol vir al die produksie-eienskappe, behalwe MFD. Geboortestatus het geen betekenisvolle effek op QUAL, OIL, SF, COL en PAS gehad nie. Die oorerflikhede vir die verskillende eienskappe was soos volg: 0.34 vir BW, 0.23 vir CFW, 0.44 vir MFD, 0.70 vir SL, 0.32 vir FS, 0.27 vir QUAL, 0.23 vir VAR, 0.24 vir OIL, 0.09 vir SF, 0.17 vir BP, 0.35 vir HEAD, 0.17 vir COL, 0.21 vir FQ, 0.12 vir PAS, 0.26 vir HOC en 0.31 vir CON. Die standaardfoute vir hierdie beramings het van 0.03 tot 0.06 gewissel. Daar word aanbeveel dat die oorerflikhede gebruik word in die berekening van seleksie-indeks wegingsfaktore, sowel as EPDs in die Nasionale Nageslagtoetsskema.

Keywords: Heritability estimates, Merino sheep, production traits, type traits

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A selection programme for Merino sheep suggested by Poggenpoel & Van der Merwe (1975) has been widely implemented in the stud industry. One of the shortcomings of this programme was that variances and covariances for production traits used for the construction of a selection index were taken from results in the literature. Furthermore, in the past, all heritability estimates for South African Merino sheep were obtained from closed experimental flocks and these may differ from industry-based data.

The National Progeny Testing Scheme of the Merino Breeder's Society forms an integral part of the South African Performance Testing Scheme for woolled sheep. The purpose of the National Progeny Testing program is to identify superior AI-rams and to create vital genetic links between flocks, for the estimation of breeding values for the Merino breed on a national basis.

In the National Progeny test several production traits, as well as 11 type traits, are recorded. Type traits were introduced only recently and therefore no heritability estimates were available. The objective of this study was to estimate heritabilities of production and type traits, for use in national breeding plans.

Data collected in 30 genetically linked flocks over a six-year period (1991–1996) were used for analyses. At 15 to 18 months of age all animals were measured for body weight (BW), clean fleece weight (CFW), mean fibre diameter (MFD), fold (wrinkle) score (FS) and staple length (SL) as described by Erasmus *et al.* (1990).

Scoring of type traits on a linear scale was performed approximately one month before shearing as described by Olivier *et al.* (1987). Type traits included in the analyses were wool quality (QUAL), variation in crimps over the fleece (VAR), wool yolk (OIL), staple formation (SF), belly and points (BP), size of head (HEAD), colour (COL), fore quarters (FQ), pasterns (PAS), hocks (HOC) and conformation (CON).

Only sires with more than five progeny were retained for analysis which resulted in the exclusion of 14 sires and their progeny. After editing, data were available for 5342 progeny (2530 ram and 2812 ewe progeny) from 232 sires, giving an effective number of 20.65 progeny per sire.

In an analyses of variance, using mixed model least-squares procedures (Harvey, 1990), the following general mixed model was fitted for each trait:

$$Y_{ijklmn} = \mu + p_i + b_j + s_k + HYS_l + ad_m + (HYSb)_{lj} + (HYSs)_{lk} + e_{ijklmn}$$

Where:

Y_{ijklmn} = observation of the j^{th} birth status of the k^{th} sex of the l^{th} herd-year-season of the m^{th} age of dam on the n^{th} progeny for sire i,

μ = population mean of the trait,

p_i = random effect of the i^{th} sire (i = 1, ... 232),

b_j = effect of the j^{th} birth status (j = 1,2),

s_k = effect of the k^{th} sex (k = 1,2),

HYS_l = effect of the l^{th} herd-year-season (l = 1,... 36),

ad_m = effect of the m^{th} age of dam (m = 1,2),

$(HYSb)_{lj}$ = effect of the interaction between the l^{th} herd-year-season and the j^{th} birth status,

$(HYSs)_{lk}$ = effect of the interaction between the l^{th} herd-year-season and the k^{th} sex, and

e_{ijklmn} = random error

The identities of the dams were not known. According to Erasmus *et al.* (1990) parameter estimates obtained from sire models using REML or Henderson's method III are in close agreement and there seems little point in using REML unless all relationships among animals can be utilized. Therefore heritabilities were estimated by means of Henderson's method III using the LSMLMW programmes of Harvey (1990). Only significant ($P \leq 0.01$) fixed effects for each trait were included in the model (Table 2).

The means, standard deviations and coefficients of variation (CV) for all traits analysed, are given in Table 1. The means of the production traits are of the same order as those reported by Poggenpoel & Van der Merwe (1992) and Snyman *et al.* (1996), but lower than those calculated by Olivier *et al.* (1997).

Table 1 Means, standard deviations and coefficient of variation of production and type traits

Trait	Mean	SD	CV (%)
Body weight (BW)	36.66 (kg)	7.18	19.59
Clean Fleece weight (CFW)	3.43 (kg)	0.98	28.57
Mean fibre diameter (MFD)	19.31 (μ)	1.33	6.89
Staple length (SL)	10.25 (cm)	1.62	15.80
Fold score (FS)	4.70	1.96	41.70
Quality (QUAL)	29.44	7.28	24.73
Variation (VAR)	32.35	7.95	24.57
Wool yolk (OIL)	24.58	2.56	10.41
Staple formation (SF)	28.36	6.44	22.71
Belly and points (BP)	25.15	6.34	25.21
Head size (HEAD)	27.96	6.52	23.32
Colour (COL)	35.03	9.51	27.15
Fore quarters (FQ)	26.29	5.66	21.53
Pasterns (PAS)	36.65	7.57	20.65
Hocks (HOC)	23.65	4.10	17.34
Conformation (CON)	27.53	6.78	24.63

The CV of MFD, CFW and BW accords well with results in the literature (Cloete *et al.*, 1992; Olivier *et al.*, 1997). The CV of type traits ranges from 10 to 40% and corresponds with results from Olivier *et al.* (1997). The relatively lower CV for OIL and HOCKS may be due to the linear scoring method used for these traits. For these traits the intermediate value was considered as optimal. In general the means of the type traits accords with the results of Olivier *et al.* (1997). From Table 2 it is evident that in all traits analysed the effect of herd-year-season (HYS) was significant ($P \leq 0.01$). For the production traits, excluding MFD, the interaction between HYS and sex was significant. Birth status had no significant effect ($P \geq 0.05$) on QUAL, OIL, SF, COL and PAS. The significant effect of sex for type traits could probably be ascribed to the different environments under which rams and ewes were raised. Age of dam proved to be non-significant for all traits and was not included.

Table 2 Model specification for production and type traits

EFFECT	HYS	HYS_s	B	s
df TRAIT	35	67	1	1
Body weight(BW)	-	*	*	-
Clean leece weight(CFW)	-	*	*	-
Mean fibre diameter (MFD)	-	*	*	-
Fold score (FS)	*	-	*	*
Staple lengte (SL)	-	*	*	-
Quality (QUAL)	*	-	-	*
Variation (VAR)	*	-	*	*
Wool yolk (OIL)	*	-	-	*
Staple formation (SF)	*	-	-	*
Belly and points (BP)	*	-	*	*
Head size (HEAD)	*	-	*	*
Colour (COL)	*	-	-	*
Fore quarters (FQ)	*	-	*	*
Pasterns (PAS)	*	-	-	*
Hocks (HOC)	*	-	*	*
Conformation (CON)	*	-	*	*

* = $P \leq 0.01$; df = degrees of freedom; HYS = interlaced effect of herd, year and season; HYS_s = interlaced effect of herd, year, season and sex; B = birth status; s = sex

Heritability estimates for BW and CFW (Table 3) are slightly lower than estimates reported by Poggenpoel & Van der Merwe (1975), Van Wyk *et al.* (1985) and Olivier *et al.* (1997). Most other heritability estimates obtained in this study were of the same order as estimates obtained by Olivier *et al.* (1997) on research flocks. Heritability estimates for MFD and FS accords well with those reported for South African Merino sheep, but the estimate for SL was higher than heritability estimates reported in literature (Van Wyk *et al.*, 1985; Olivier *et al.*, 1997) and should be viewed with caution.

A popular breeding objective in the Merino industry at present is to increase body weight, keep wool weight constant and to reduce mean fibre diameter and number of folds. Most breeders achieve this by applying the selection index as described by Poggenpoel & Van der Merwe (1975). The heritability estimates used by Poggenpoel & Van der Merwe (1975) to calculate the selection index weighting factors differ slightly from the heritability estimates in this study. Therefore it can be recommended that these estimates be used for construction of national as well as individual selection indices. The estimates calculated for type traits can also be implemented in the National Progeny Testing Scheme for the calculation of EPD's.

Table 3 Heritability estimates for production and type traits

Trait	Heritability	SE
Body weight (BW)	0.34	0.04
Clean fleece weight (CFW)	0.23	0.04
Mean fibre diameter (MFD)	0.44	0.05
Staple length (SL)	0.70	0.06
Fold score (FS)	0.32	0.04
Quality (QUAL)	0.27	0.04
Variation (VAR)	0.23	0.04
Wool yolk (OIL)	0.24	0.04
Staple formation(SF)	0.09	0.03
Belly and points (BP)	0.17	0.03
Head size (HEAD)	0.35	0.04
Colour (COL)	0.17	0.03
Fore quarters (FQ)	0.21	0.03
Pasterns (PAS)	0.12	0.02
Hocks (HOC)	0.26	0.04
Conformation (CON)	0.31	0.04

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