Production parameters for a commercial Dorper flock on extensive pastures

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Data of 1483 birth and 1209 weaning records of Dorper lambs in a commercial flock were used to investigate the effects of environmental factors on birth and weaning mass, and on pre-weaning growth and survival. Pre-weaning survival was relatively high (0,91) and largely independent of the known sources of variation. The effects of dam age, sex and rearing type on birth mass, weaning mass and pre-weaning growth rate were in agreement with literature cited. Weaning mass was also affected by weaning age, with an overall linear increase of 0,167 kg in weaning mass per day of age. A data set containing 813 mating and 720 lambing records was used to investigate factors affecting mating mass and reproduction in adult ewes. Age trends in mating mass, multiple birth rate and lambs weaned/ewe mated (Lw/Em) were in agreement with literature cited. Multiple born ewes maintained a higher multiple birth rate than singles. Mating mass and conception rate were unrelated within and across age groups. There was evidence of a linear relationship between mating mass and multiple birth rate, especially in 2-year-old ewes. The effect of mating mass on multiple birth rate was partially reflected in Lw/Em. The intra-class correlation repeatabilities of mating mass, lambs born/ewe mated (Lb/Em) and Lw/Em were 0,45, 0,08 and 0,07 respectively. Repeatability estimates derived from the regression of subsequent reproduction on initial records at 2 or 3 years suggested that selection in the current flock should be directed against barrenness or failure to rear at least one lamb. The current flock gains attainable by selection are, however, relatively small, and gains of approximately 0,025 Lb/Em or Lw/Em may be achieved.

Geboorte- en speengegewens van onderskeidelik 1483 en 1209 Dorperlammers is ontleed om die invloed van omgewingsfaktore op geboorte- en speenmassa, sowel as op voorspeense massatoename en oorlewing te ondersoek. Voorspeense oorlewing was relatief hoog (0,91) en grootliks onafhanklik van die bronne van variasie wat ondersoek is. Die invloed van moederouderdom, geslag en speenstatus op geboortemassa, speenmassa en voorspeense massatoename was in ooreenstemming met aangehaalde literatuur. Speenmassa is ook deur speenouderdom beïnvloed, met 'n lineêre toename van 0,167 kg in speenmassa vir 'n toename van een dag in speenouderdom. 'n Datastel van 813 paar- en 720 lamrekords is verder gebruik om faktore wat paarmassa en reproduksie-eienskappe in volwasse ooie beïnvloed, te ondersoek. Ouderdomsneigings in paarmassa, meerlinggeboortes en lammers gespeen/ooi gepaar (Lw/Em) was in ooreenstemming met aangehaalde literatuur. Meerlinggebore ooie het 'n hoër tempo van meerlinggeboortes gehandhaaf as enkelinge. Besetting was binne en oor ouderdomsgroepe onafhanklik van paarmassa. Daar was egter aanduidings van 'n reglynige verwantskap tussen paarmassa en meerlinggeboortes, veral by ooie van 2 jaar. Die invloed van paarmassa op meerlinggeboortes is gedeeltelik oorgedra na Lw/Em. Die intraklas-korrelasie herhaalbaarhede vir paarmassa, lammers gebore/ooi gepaar (Lb/Em) en Lw/Em was onderskeidelik 0,45, 0,08 en 0,07. Herhaalbaarheidsberamings verkry van die regressie van daaropvolgende prestasie op die aanvanklike prestasie van ooie op 2 of 3 jaar, dui daarop dat seleksie vir reproduksie in die huidige kudde in die Nortier-Dorperkudde teen onbesette ooie, of ooie wat geen lammers speen nie, gerig moet word. Die vorderingsmoontlikhede in die huidige kudde is egter relatief klein en vordering van ongeveer 0,025 Lb/Em of Lw/Em word verwag.

Keywords: Dorper sheep, lamb growth, lamb survival, ewe reproduction, repeatability

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Introduction

The need for a breed suitable for slaughter lamb production in the arid, extensive regions of South Africa resulted in the formation of the Dorper breed in the early 1940s. The breed originated from a cross between the Dorset Horn and the Black Headed Persian which was developed in collaboration with officials from the Grootfontein Agricultural College (Campbell, 1986). The Dorper is a specialist mutton breed, and no attention is given to wool traits, which are considered of virtually no importance. The hardiness and adaptability of the Dorper resulted in a rapid increase in popularity, and the breed has grown to the second largest in terms of numbers in South Africa, while breeding stock have also been exported to other countries (Terblanche, 1979). Early growth and carcass characteristics of Dorper lambs were studied by Campbell (1974), but little information is available on production characteristics like reproduction and survival. Data obtained from a commercial flock on the Nortier Experimental Farm were used to investigate production parameters regarding lamb growth and survival, as well as ewe live mass and reproduction in the Dorper breed.

Material and Methods

The Nortier Experimental Farm is situated to the immediate north of Lamberts Bay. The farm is classified as representative of veld type 34 (Acocks, 1953), also described as 'the Strandveld of the Western Seaboard'. Producers in this region are recommended to utilize the natural pastures by extensive sheep or cattle production. Crop production is practised on limited scale, the major restrictions being an unpredictable rainfall, and the inherent instability of the soil.

The Nortier Dorper flock was established in 1973, forming part of a pasture science project where the utilization of extensive pastures by different farm livestock species was studied. Originally the flock consisted of one group of 60 breeding ewes, but in 1975 a second group of 35 breeding ewes was added. Both groups were maintained at a constant stocking rate of approximately 4,35 ha/SSU. Differences between these groups were not significant, and they were pooled in the present investigation. No specific breeding policy was followed in the flock, and breeding rams were obtained from the Grootfontein Research Station. Replacement ewes were selected on conformation and breed characteristics at 14 – 16 months. Mass mating with 3% rams was implemented for a period of 6 weeks in December/January. Other managerial practices in the flock were reported by de Villiers (1982).

Data regarding 1483 lambs born from 1973 to 1984 were analysed. These data included 22 stillborn lambs which were not weighed nor sexed. Weaning records of 1209 of the above lambs (excluding lambs born in 1978, when poor pasture conditions necessitated the early weaning and feedlot finishing of all lambs) which were weaned at an average age of 138 ± 12 days were furthermore available. The effects of birth year, dam age, sex and birth type on birth mass and lambs weaned/lamb born alive (Lw/Lba) were investigated by least squares procedures, using the LSML76 computer program (Harvey, 1977). Sex was not included as an independent variable in the analyses on lambs born alive/lamb born (Lba/Lb) and lambs weaned/lamb born (Lw/Lb), where the stillborn lambs had been included. The Bonferoni method (van Ark, 1981) was used to test means for significant differences. The linear regressions of weaning mass on weaning age were used to adjust weaning mass data within birth years for age differences before pre-weaning growth rate was calculated. The independent variables specified above were used in the analyses on weaning mass and pre-weaning growth rate. The final runs of all the above analyses excluded the applicable two-factor interactions, which were unimportant sources of variation. Significance tests for year effects are given, but within- year means are not included in the tables or discussions, as it is difficult to account for differences between years under extensive conditions, seeing that they mainly originate from a variety of climatic conditions.

Factors affecting live mass and reproduction rate of ewes were subsequently considered. The relevant information for ewes born prior to 1973 was incomplete, and a data set containing 813 mating records from the lambing years 1975 to 1984 was thus considered. Lambing years, age, dam age and birth type were used as independent variables in least squares analyses on pre-mating live mass, ewes conceived/ewe mated (Ec/Em), lambs born/ewe lambed (Lb/El) and the composite trait lambs weaned/ewe mated (Lw/Em). Ewes available for mating were referred to as mated, while individual ewes were treated as separate individuals with every lambing opportunity. The statistical procedures implemented were similar to those described for lamb live mass and survival. The regressions of Ec/Em, Lb/El and Lw/Em on pre-mating live mass were subsequently investigated. Apart from the overall regressions of the dependent variables on pre-mating live mass, individual class regressions were simultaneously fitted for ewes belonging to different age groups. Significant deviations from zero were determined by t test procedures (van Ark, 1981).

The repeatability of pre-mating live mass, lambs born/ewe mated (Lb/Em) and Lw/Em was derived from intra-class correlations (Turner & Young, 1969). Between and within ewe variance components were obtained by mixed model methods, using the LSML76 computer program (Harvey, 1977). The specific model included the random effect of ewes within birth years, the fixed effect of ewe age, and the random error term. Only ewes available for at least two lambing opportunities were considered. The data set included 840 mating records of 212 ewes born in the period from 1971 to 1981. The repeatability of Lb/Em and Lw/Em was also estimated by the regression method of Lush (1956). The average subsequent reproduction of ewes bearing or rearing no, one or two lambs at 2 or 3 years of age was obtained from least squares analyses (Harvey, 1977). Repeatability was estimated as the difference in subsequent reproduction between ewes belonging to adjacent classes. Procedures presented by Turner & Young (1969) were used to pool applicable estimates and calculate appropriate standard errors. Ewes available for one subsequent lambing season only were excluded. Records of 183 and 153 ewes were available to regress subsequent reproduction on reproduction at 2 and 3 years respectively.

Results and Discussion

Lamb live mass and survival

Results regarding birth mass and pre-weaning survival are presented in Table 1. The birth mass of lambs from adult dams was significantly ($P \leq 0,05$) higher than in lambs with 2-year-old dams. Sex and birth type similarly affected birth mass ($P \leq 0,01$), ram lambs being heavier than ewes, and singles being heavier than multiples. These results are in close agreement with those reported in the literature for mutton and dual-purpose breeds (El-tawil, Hazel, Sidwell & Terrill, 1970; van der Merwe, 1976; Atkins, 1980a; Galal & Awgichew, 1981; Fourie & Heydenrych, 1982) and are therefore not discussed any further.

The overall survival rate of lambs in the Nortier Dorper flock was relatively high (0,91) compared to the Elsenburg Dormer and S.A. Mutton Merino flocks, where respective mortality rates of 0,18 and 0,24 were reported (Brand, Cloete & de Villiers, 1985). Survival also tended to be largely independent of the known sources of variation in the present investigation. Lambs borne by 6-year-old ewes tended ($P=0,06$) to have a higher probability of survival from birth to weaning than lambs with 2-year-old dams (Table 1). Multiple-born lambs sustained less ($P \leq 0,05$) mortalities during birth than singles. The advantage was, however, cancelled by a lower ($P \leq 0,05$) survival rate from birth to weaning in multiples, resulting in no effect of birth type on Lw/Lb.

Table 1 Least squares means and significance tests associated with factors influencing birth mass and survival of Dorper lambs.

Effect	Number of lambs Born	Alive	Birth mass (kg)	Lambs born alive/lamb born	Lambs weaned/lamb born alive	Lambs weaned/ lamb born
Overall mean	1483	1461	4,1	0,98	0,93	0,91
Birth year			**	*	**	ns
Dam age			**	ns	ns	ns
2 years	333	327	3,8[a]	0,98	0,90	0,89
3 years	322	316	4,1[b]	0,98	0,91	0,89
4 years	291	289	4,1[b]	0,99	0,92	0,91
5 years	234	232	4,1[b]	0,98	0,96	0,94
6 years	179	176	4,2[b]	0,98	0,97	0,94
7+ years	124	121	4,0[b]	0,97	0,91	0,89
Sex			**	–	ns	–
ram(wether)	–	713	4,2[1]		0,93	
ewe	–	748	3,9[2]		0,93	
Birth type			**	*	*	ns
Single	406	396	4,3[1]	0,97[a]	0,95[a]	0,92
multiple	1077	1065	3,8[2]	0,99[b]	0,91[b]	0,90

ns — Not significant; * Significant ($P \leq 0{,}05$); ** Significant ($P \leq 0{,}01$); [a,b] Denote significance ($P \leq 0{,}05$) in columns; [1,2] Denote significance ($P \leq 0{,}01$) in columns

The general opinion in the literature favours a lower survival rate among multiples compared to singles (Atkins, 1980a; Alexander, Stevens & Lynch, 1980). There is, however, indications that the survival rate of twins and singles is similar in flocks with relatively high levels of prolificacy (Notter & Copenhaver, 1980; Brand, *et al.*, 1985). The survival rate of triplet lambs is generally considerably lower than in singles and twins. The low proportion of triplets (0,022) in the present investigation may have added to the obtained results. It should be noted that the introduction of birth mass as a covariate in the model used to analyse Lw/Lba completely eliminated the effect of birth type and the tendency towards significant differences between dam age groups, as was also found by Dalton, Knight & Johnson (1980). Differences in the survival of lambs belonging to different birth type and dam age classes therefore appear to be related to birth mass differences.

The overall regression of weaning mass on weaning age indicated that weaning mass increased by 0,167 ± 0,017 kg per day of age. Similar results in the literature suggest values between 0,13 and 0,21 kg for a variety of sheep breeds (Eltawil, *et al.*, 1970; Hight & Jury, 1971; Gregory, Roberts & James, 1977; Galal & Awgichew, 1981; Napier & Jones, 1982). Individual class regressions of weaning mass on weaning age differed significantly ($P \leq 0{,}01$) between birth year groups, ranging from -0,022 ± 0,047 to 0,273 ± 0,028 kg per day of age. Corrections for weaning age by average daily gain from birth to weaning would thus be invalid in some birth years, as was also reported by Ransom & Mullaney (1976). The bias introduced by inadequate age corrections may be reduced by the weaning of lambs in groups according to birth date to reduce the variation in weaning age.

Table 2 Least squares means and significance tests associated with factors influencing weaning mass and pre-weaning growth rate of Dorper lambs.

Effect	Number of lambs	Weaning mass (kg)	Pre-weaning gain (kg/day)
Overall mean	1209	41,3	0,273
Birth year		**	**
Dam age		**	*
2 years	264	40,0[1]	0,271[a,b]
3 years	241	42,4[3]	0,280[b]
4 years	235	42,1[2,3]	0,277[a,b]
5 years	205	41,7[2,3]	0,273[a,b]
6 years	155	41,5[2]	0,272[a,b]
7+ years	109	40,2[1,2]	0,263[a]
Sex		**	**
wether	582	42,7[1]	0,282[1]
ewe	627	39,9[2]	0,263[2]
Birth and weaning type		**	**
Single/Single	337	43,2[1]	0,283[1]
Multiple/Single	58	41,8[1]	0,280[1]
Multiple/Multiple	814	39,0[2]	0,256[2]

ns — Not significant; * Significant ($P \leq 0{,}05$); ** Significant ($P \leq 0{,}01$); [a,b] Denote significance ($P \leq 0{,}05$) in columns; [1,2,3] Denote significance ($P \leq 0{,}01$) in columns

Adjusted weaning mass and pre-weaning growth rate were significantly ($P \leq 0{,}05$) affected by all the known sources of variation (Table 2). The weaning mass of lambs from 2-year-old dams was significantly ($P \leq 0{,}01$)

lower than in lambs with adult dams, with the exception of the dam age group of 7 years and older. These results are in general agreement with tendencies reported in the literature (Eltawil, *et al.*, 1970; Van der Merwe, 1976; Fourie & Heydenrych, 1982; Napier & Jones, 1982). Dam age effects on pre-weaning growth rate were less pronounced, the only significant ($P \leq 0{,}05$) difference being between lambs with 3-year-old dams and those with 7 year and older dams. Birth mass differences therefore contribute to the variance in weaning mass attributable to dam age, as was also suggested by results published by Eltawil, *et al.* (1970). The weaning mass and pre-weaning growth rate of wether lambs were significantly ($P \leq 0{,}01$) higher than in ewes, as was also reported by Hight & Jury (1971) and Atkins (1980a). The weaning mass of single lambs and multiples reared as singles was significantly ($P \leq 0{,}01$) higher than in multiples. The weaning mass means reported in Table 2 for the respective birth/rearing classes accord with other reports (Eltawil, *et al.*, 1970; Hight & Jury, 1971; Ransom & Mullaney, 1976; Napier & Jones, 1982). The effect of birth/rearing type on pre-weaning growth rate was less pronounced than on weaning mass, indicating that the higher birth mass of singles contributed to the weaning mass differences between singles and the other birth/rearing type classes, as was also reported by Eltawil, *et al.* (1970).

Ewe live mass and reproduction

Results regarding mating mass and reproduction of ewes are presented in Table 3. After a significant ($P \leq 0{,}01$) increase in mating mass from the first to the second mating, mating mass remained relatively stable at approximately 73 kg, before tending to decline after five matings. This tendency in mating mass with an increase in age is in general agreement with comparable results in the literature (Coop, 1973; van der Merwe, 1976). Lambs born/ewe lambed and Lw/Em similarly increased ($P \leq 0{,}01$) to peak at an age of 5 – 6 years, before tending to decline at later ages. These tendencies are also in agreement with results in the literature (Coop, 1973; Atkins, 1980b; Olivier, 1982) and are therefore not discussed in detail. The only significant dam age effect was for Lb/El where ewes borne by 7 year and older dams tended to have a significantly ($P \leq 0{,}05$) lower multiple birth rate than those borne by 2 and 4-year-old dams (Table 3). In this respect, Cloete & Heydenrych (1986) reported no dam age effect on reproduction traits included in their investigation. No evident explanation can be given for the effect of dam age on Lb/El in the Nortier Dorper flock, and it should perhaps be regarded as coincidental, unless substantiated by further research. Mating mass and Ec/Em were relatively independent of birth type (Table 3). Multiple born ewes had a significantly ($P \leq 0{,}05$) higher multiple birth rate than singles, as was also reported by several sources in the literature (Turner, 1969; van der Merwe, 1976; Kritzinger, Stindt & van der Westhuysen, 1984; Cloete & Heydenrych, 1986). Birth type may thus be implemented to select for multiple birth rate in the Nortier Dorper flock. Ovulation rate does, however, appear to have some advantages over birth type as a selection criterion for increased

Table 3 Least squares means and significance tests associated with factors influencing mating mass and reproduction of Dorper ewes.

Effect	Number of ewes Mated	Lambed	Mating mass (kg)	Ewes conceived/ ewe mated	Lambs born/ ewe lambed	Lambs weaned ewe mated
Overall mean	813	720	72,3	0,89	1,59	1,30
Lambing year			**	**	*	ns
Age			**	ns	**	**
2 years	235	201	$68{,}9^{1}$	0,86	$1{,}43^{1}$	$1{,}12^{1}$
3 years	193	165	$73{,}6^{2}$	0,86	$1{,}56^{1,2}$	$1{,}19^{1,2}$
4 years	157	140	$73{,}1^{2}$	0,90	$1{,}47^{1}$	$1{,}19^{1,2}$
5 years	107	101	$73{,}3^{2}$	0,92	$1{,}67^{2}$	$1{,}45^{2}$
6 years	71	66	$73{,}0^{2}$	0,89	$1{,}73^{2}$	$1{,}49^{2}$
7+ years	50	47	$72{,}1^{1,2}$	0,93	$1{,}59^{1,2}$	$1{,}35^{1,2}$
Dam age			ns	ns	*	ns
2 years	148	129	72,0	0,89	$1{,}65^{b}$	1,35
3 years	169	148	72,9	0,88	$1{,}60^{a,b}$	1,32
4 years	191	173	72,9	0,91	$1{,}59^{a,b}$	1,29
5 years	137	122	71,4	0,90	$1{,}58^{a,b}$	1,24
6 years	110	96	73,4	0,88	$1{,}67^{b}$	1,39
7+ years	58	52	71,2	0,90	$1{,}37^{a}$	1,19
Birth type			ns	ns	*	ns
Single	247	219	72,6	0,88	$1{,}53^{a}$	1,26
Multiple	566	501	72,0	0,89	$1{,}62^{b}$	1,33

ns — Not significant; * Significant ($P \leq 0{,}05$); ** Significant ($P \leq 0{,}01$); ^{a,b} Denote significance ($P \leq 0{,}05$) in columns; ^{1,2} Denote significance ($P \leq 0{,}01$) in columns prolificacy in flocks where Lb/El exceeds 1,40 (Piper & Bindon, 1984). This aspect must be considered in future research if further increases by means of breeding in the reproduction rate of Dorper sheep are envisaged. Multiple born ewes tended to wean more lambs per mating than singles, but the difference was not statistically significant (P=0,17).

The overall and within age group regressions of the reproduction traits on mating mass are presented in Table 4. Ec/Em was independent of mating mass, both within and across age groups. Cloete & Heydenrych (1986) found conception rate to be independent of mating mass in Merino ewes belonging to age groups of 3 – 6 years, but a linear relationship existed in 2-year-old ewes. The lack of a relationship between Ec/Em and mating mass in 2-year-old ewes of the present investigation may be related to early maturity and sexual development of Dorper lambs. Multiple birth rate, on the other hand, was linearly associated ($P \leq 0,05$) with mating mass in ewes belonging to the age groups of 2, 3 and 5 years, and across age groups. The linear regression coefficient of 0,0156 Lb/El for an increase of 1 kg in mating mass of 2-year-old ewes is similar to the average of seven corresponding estimates in the literature reported by Cloete & Heydenrych (1986), and in close agreement with the estimate of 0,0153 obtained by the authors cited. The phenotypic relationship between mating mass and reproduction thus appears to be positive in the Nortier Dorper flock, and particularly at 2 years. Selection on live mass at 18 months of age is likely to improve multiple birth rate in the subsequent lambing season. The effect of mating mass on Lb/El was partially reflected in Lw/Em as well. The linear regression of 0,0169 Lw/Em for an increase of 1 kg in mating mass in 2-year-old ewes is in general agreement with estimates in the literature (Dalton & Rae, 1978; Cloete & Heydenrych, 1986). Mating mass did not significantly influence Lw/Em in age groups older than 3 years.

The repeatability of mating mass and lambs born and weaned per ewe mated, as determined by the intra-class correlation method, is presented in Table 5. The repeatability of mating mass was 0,45, which is just below the range of estimates for Merino sheep reviewed by Turner & Young (1969). Selection on live mass at 18 months is likely to increase the slaughter mass and the salvage value of ewes when they are culled on poor production, or cast for age. The repeatability of the reproduction traits was relatively low. The estimate of 0,08 for Lb/Em is nevertheless in good agreement with estimates for several sheep breeds in the literature, which range from 0,04 to 0,10 (Young, Turner & Dolling, 1963; Mann, Taplin & Brady, 1978; Fogarty, Dickerson & Young, 1985). The estimate of 0,07 for Lw/Em is similarly in agreement with estimates in the literature, ranging from 0,01 to 0,08 (Young, *et al.*, 1963; Purser, 1965; Fogarty, *et al.*, 1985). It should be noted that several higher estimates than those reported here are also available in the literature with regard to both Lb/Em and Lw/Em (Inskeep, Barr & Cunningham, 1967; Fogarty, McGuirk & Nicholls, 1976; Dzakuma, Whiteman & McNew, 1982).

According to Turner (1969) the intra-class correlation method assumes linearity in the subsequent reproduction of ewes belonging to different reproduction classes initially. This assumption is not always satisfied, resulting in the above-mentioned differences between estimates in the literature, as well as between estimates derived from intra-class correlations and from the regression of subsequent reproduction on earlier reproduction.

Table 4 The regressions of ewes conceived/ewe mated, lambs born/ewe lambed and lambs weaned/ewe mated on mating mass within and across age groups of 2 – 7 years and older.

Age group	Ewes conceived/ ewe mated	Lambs born/ ewe lambed	Lambs weaned/ ewe mated
2 years	0,0007 ± 0,0030	0,0156[b] ± 0,0051	0,0169[b] ± 0,0069
3 years	0,0037 ± 0,0028	0,0108[a] ± 0,0047	0,0141[a] ± 0,0064
4 years	-0,0005 ± 0,0030	0,0005 ± 0,0051	0,0016 ± 0,0068
5 years	-0,0018 ± 0,0033	0,0105[a] ± 0,0053	0,0018 ± 0,0076
6 years	0,0035 ± 0,0049	0,0013 ± 0,0097	-0,0033 ± 0,0111
7+ years	-0,0081 ± 0,0057	0,0136 ± 0,0097	-0,0100 ± 0,0130
Across age groups	-0,0004 ± 0,0018	0,0087[b] ± 0,0029	0,0046 ± 0,0040

[a] Significant ($P \leq 0,05$); [b] Significant ($P \leq 0,01$)

Table 5 Repeatability (t) estimates for production traits in Dorper ewes, determined by intra-class correlation or by regression methods

Intra-class correlation[a]

Production trait	Variance components Between	Within	Repeatability ($t \pm SE$)
Mating mass	29,9553	37,0910	0,45 ± 0,04
Lambs born/ewe mated	0,0387	0,4235	0,08 ± 0,03
Lambs weaned/ewe mated	0,0361	0,4629	0,07 ± 0,03

Regression

Production trait and age of initial record	Number of lambs born or weaned 0	1	2	Pooled t ($\hat{t} \pm SE$)
Lambs born/ewe mated[b]				
2 years	1,27(24)	1,42(91)	1,47(68)	0,09 ± 0,04
3 years	1,24(16)	1,42(54)	1,50(83)	0,11 ± 0,04
Pooled t ($\hat{t} \pm SE$)	0,16 ± 0,01	0,07 ± 0,01		
Lambs weaned/ewe mated[b]				
2 years	1,19(35)	1,36(95)	1,28(53)	0,03 ± 0,13
3 years	1,18(20)	1,31(64)	1,44(69)	0,13 ± 0,01
Pooled t ($\hat{t} \pm SE$)	0,15 ± 0,02	0,06 ± 0,10		

[a] Based on 202 degrees of freedom between and 623 within individuals with a k value of 3,944

[b] Number of observations are given in parenthesis

Repeatability of Lb/Em and Lw/Em was therefore also estimated by the regression method. The average subsequent reproduction of ewes bearing or weaning no, one or two lambs at 2 or 3 years of age is presented in Table 5, together with appropriate repeatability estimates. The estimates for Lb/Em suggested non-linearly in the subsequent reproduction of ewes belonging to different reproduction classes initially. The difference between ewes bearing no and one lambs was twice as large as between those ewes bearing one and two lambs. Results in the literature are conflicting with regard to this aspect. Results supporting the present investigation were reported by Inskeep, *et al.* (1967), van der Merwe (1976), Fogarty, *et al.* (1976) and Kritzinger, *et al.* (1984). There is, however, ample evidence of flocks where the magnitude of these differences was reversed, with the subsequent difference between ewes bearing one and two lambs being larger than between those bearing no and one lambs (Young, *et al.*, 1963; van der Westhuysen, 1973; More O'Ferrall, 1976; Poggenpoel, Hart & Lund, 1984; Cloete & Heydenrych, 1987). Other authors reported differences of approximately the same magnitude between ewes belonging to different initial reproduction classes (Dzakuma, *et al.*, 1982). The results from the present study nevertheless indicate that progress amounting to approximately 0,025 Lb/Em can be made in the current flock, when ewes barren at 2 or 3 years of age are culled. The progress is limited by the rather low proportion barren ewes in their early lambing seasons in the Nortier Dorper flock. Contrary to most of the results in the literature, the advantage of selecting ewes bearing two lambs in either of their first two lambing seasons is limited in this flock.

The pooled repeatability estimate for Lw/Em in 2-year-old ewes is small with a large standard error (Table 5) because of a lower average subsequent rearing performance in ewes rearing two lambs at 2 years in comparison with ewes rearing one lamb. Ewes rearing one lamb at 2 or 3 years consistently reared approximately 0,14 lambs more per ewe mated in subsequent lambing seasons than ewes rearing no lambs. Corresponding results presented by Inskeep, *et al.* (1967) and Cloete & Heydenrych (1987) support this finding. In contrast to this tendency, Young, *et al.* (1963) and Lewer, Rae & Wickham (1983) found a small difference between ewes rearing one lamb initially and those rearing no lambs. Current flock gains by the culling of ewes rearing no lambs initially amounted to approximately 0,025 Lw/Em. Results in the literature suggest the average subsequent rearing performance of ewes rearing two lambs initially to be higher than in those rearing one lamb (Young, *et al.*, 1963; Inskeep, *et al.*, 1967; Lewer, *et al.*, 1983; Cloete & Heydenrych, 1987). The present investigation followed this trend only when ewes were classified according to their reproduction at 3 years.

In general, it appears that selection for reproduction rate in the current flock should be directed against barrenness or failure to rear at least one lamb in the Nortier Dorper flock. Multiple birth rate was not highly repeatable, while no advantage in the current flock could be demonstrated in the selection of ewes rearing two lambs at 2 years of age. The gain in the current flock attainable by discrimination against barrenness or failure to rear at least one lamb is, however, limited and will result in gains of approximately 0,025 lambs born or weaned per ewe mated.

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References

ACOCKS, J.P.H., 1953. Veld types of South Africa. Mem. bot. survey. Governmental Printer, Pretoria.

ALEXANDER, G., STEVENS, D. & LYNCH, J.J., 1980. Inadequate maternal care: a factor contributing to the differential mortality of singles and twins in fine-woolled Merino sheep. *Proc. Aust. Soc. Anim. Prod.* 13, 496.

ATKINS, K.D., 1980a. The comparative productivity of five ewe breeds. 1. Lamb growth and survival. *Aust. J. Exp. Agric. Anim. Husb.* 20, 272.

ATKINS, K.D., 1980b. The comparative productivity of five ewe breeds. 3. Adult ewe performance. *Aust. J. Exp. Agric. Anim. Husb.* 20, 288.

BRAND, A.A., CLOETE, S.W.P. & DE VILLIERS, T.T., 1985. Faktore wat lamvrektes by die Elsenburg Dormer- en S.A. Vleismerinokuddes beïnvloed. *S.-Afr. Tydskr. Veek.* 15, 155.

CAMPBELL, Q.P., 1974. A study of breeding problems in Dorper sheep. D.Sc. (Agric.) thesis, University of the Orange Free State.

CAMPBELL, Q.P., 1986. Die Dorper — 'n suksesverhaal van veeverbetering. *Navorsingskeur* 1986, 27.

CLOETE, S.W.P. & HEYDENRYCH, H.J., 1986. Factors affecting reproduction in the Tygerhoek Merino flock. *S. Afr. J. Anim. Sci.* 16, 36.

CLOETE, S.W.P. & HEYDENRYCH, H.J., 1987. The repeatability of reproduction rate in the Tygerhoek Merino flock. *S. Afr. J. Anim. Sci.* 17, 17.

COOP, I.E., 1973. Age and live weight in sheep. *N. Z. J. Exp. Agric.* 1, 65.

DALTON, D.C., KNIGHT, T.W. & JOHNSON, D.L., 1980. Lamb survival in sheep breeds on New Zealand hill country. *N. Z. J. Agric. Res.* 23, 167.

DALTON, D.C. & RAE, A.L., 1978. The New Zealand Romney Sheep: A review of productive performance. *Anim. Breed. Abstr.* 46, 657.

DE VILLIERS, T.T., 1982. Die bestuur van 'n vleisskaapkudde. Verslag van 'n simposium aangebied deur die Weskaaptak van die S.A.V.D.P., Upington 1982, 11.

DZAKUMA, J.M., WHITEMAN, J.V. & McNEW, K.W., 1982. Repeatability of lambing rate. *J. Anim. Sci.* 54, 540.

ELTAWIL, E.A., HAZEL, L.N., SIDWELL, G.M. & TERRILL, C.E., 1970. Evaluation of environmental factors affecting birth, weaning and yearling traits in Navajo sheep. *J. Anim. Sci.* 31, 823.

FOGARTY, N.M., DICKERSON, G.E. & YOUNG, L.D., 1985. Lamb production and its components in pure breeds and composite lines. 3. Genetic parameters. *J. Anim. Sci.* 60, 40.

FOGARTY, N.M., McGUIRK, B.J. & NICHOLLS, P.J., 1976. Reproductive performance of Border Leicester ewes. *Proc. Aust. Soc. Anim. Prod.* 11, 117.

FOURIE, A.J. & HEYDENRYCH, H.J., 1982. Phenotypic and genetic aspects of production in the Dohne Merino. I. The influence of non-genetic factors on production traits. *S. Afr. J. Anim. Sci.* 12, 57.

GALAL, E.S.E. & AWGICHEW, K., 1981. Ethiopian Adal sheep: Genetic and environmental factors affecting body weights and postweaning gain. *Int. Goat Sheep Res.* 1, 310.

GREGORY, I.P., ROBERTS, E.M. & JAMES, J.W., 1977. Genetic improvement of meat sheep. II. Correction of weaning weight in Dorset and Border Leicester sheep. *Aust. J. Exp. Agric. Anim. Husb.* 17, 31.

HARVEY, W.R., 1977. User's guide for LSML76 - Mixed model least squares and maximum likelihood computer program. Ohio State University, Ohio, USA.

HIGHT, G.K. & JURY, K.E., 1971. Hill country sheep production. 3. Sources of variation in Romney and Border Leicester × Romney lambs and hoggets. *N. Z. J. Agric. Res.* 14, 669.

INSKEEP, E.K., BARR, A.K. & CUNNINGHAM, C.J., 1967. Repeatability of prolificacy in sheep. *J. Anim. Sci.* 26, 458.

KRITZINGER, N.M., STINDT, H.W. & VAN DER WESTHUYSEN, J.M., 1984. Assessment of different selection criteria for reproduction rate in Dormer and S.A. Mutton Merino sheep. 1. Birth type and early reproductive performance of the ewe. *S. Afr. J. Anim. Sci.* 14, 79.

LEWER, R.P., RAE, A.L. & WICKHAM, G.A., 1983. Analyses of records of a Perendale flock. V. Repeatabilities and genetic correlations between ages. *N. Z. J. Agric. Res.* 26, 315.

LUSH, J.D., 1956. Query. *Biometrics* 12, 84.

MANN, T.L.F., TAPLIN, D.E. & BRADY, R.E., 1978. Response to partial selection for fecundity in Merino sheep. *Aust. J. Exp. Agric. Anim. Husb.* 18, 635.

MORE O'FERRALL, G.J., 1976. Phenotypic and genetic parameters of productivity in Galway ewes. *Anim. Prod.* 23, 295.

NAPIER, K.M. & JONES, L.P., 1982. Effect of age, maternal handicap, birth and survival type on five fleece and body characters of Corriedale rams. *Aust. J. Exp. Agric. Anim. Husb.* 22, 281.

NOTTER, D.R. & COPENHAVER, J.S., 1980. Performance of Finnish Landrace crossbred ewes under accelerated lambing. II. Lamb growth and survival. *J. Anim. Sci.* 51, 1043.

OLIVIER, J.J., 1982. Reproduksie-eienskappe by Merinoskape in ekstensiewe weigebiede. *S.-Afr. Tydskr. Veek.* 12, 379.

PIPER, L.R. & BINDON, B.M., 1984. Genetic and non-genetic manipulation of reproduction rate in sheep. *Proc. 2nd World Cong. Sheep and Beef Cattle Breeding (1984)*, 502.

POGGENPOEL, D.G., HART, M. & LUND, A., 1984. Die herhaalbaarheid van reproduksietempo by kommersiële Merino-ooie. *S.-Afr. Tydskr. Veek.* 14, 40.

PURSER, A.F., 1965. Repeatability and heritability of fertility in hill sheep. *Anim. Prod.* 7, 75.

RANSOM, K.P. & MULLANEY, P.D., 1976. Effects of sex and some environmental factors on weaning weight in sheep. *Aust. J. Exp. Agric. Anim. Husb.* 16, 19.

TERBLANCE, E. le F., 1979. Ken ons Kleinveerasse. Human & Rousseau Uitgewers (Edms.) Bpk., Kaapstad.

TURNER, HELEN NEWTON, 1969. Genetic improvement of reproduction rate in sheep. *Anim. Breed. Abstr.* 37, 545.

TURNER, HELEN NEWTON & YOUNG, S.S.Y., 1969. Quantitative genetics in sheep breeding. MacMillan Publishing Company (Pty) Ltd., South Melbourne, Victoria.

VAN ARK, H., 1981. Eenvoudige biometriese tegnieke en proefontwerpe met spesiale verwysing na entomologiese navorsing. *Wet. Pamf. Dep. Landb. Vis. Repub. S. Afr.* no. 396.

VAN DER WESTHUYSEN, J.M., 1973. The relationship of birth status and early reproductive performance with lifetime reproductive performance in Merino ewes. *S. Afr. J. Anim. Sci.* 3, 29.

VAN DER MERWE, C.A., 1976. Genetiese en nie-genetiese faktore wat produksie- en reproduksie-eienskappe van die Elsenburgse Dormerskaapkudde beinvloed. Ph.D. (Agric.)-proefskrif, Universiteit van Stellenbosch.

YOUNG, S.S.Y., TURNER, HELEN NEWTON & DOLLING, C.H.S., 1963. Selection for fertility in Australian Merino sheep. *Aust. J. Agric. Res.* 14, 460.