

**Short Communications / Kort Mededelings****Reproduction of Merino sheep subjected to divergent selection on maternal values for lambs weaned per ewe joined**

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Two Merino lines were established in 1988 and were subjected to divergent selection for maternal ranking values on lambs weaned/ewe joined (Lw/Ej). Replacements with high values were selected in the Reproduction '+' line, while progeny of low ranking ewes was included in the Reproduction '-' line. The number of ewes lambing/ewe joined was higher ( $P \leq 0.10$ ) in the '+' line than in the '-' line during 1989, 1991 and 1992. The proportion of multiple lambs in the '+' line was higher ( $P \leq 0.05$ ) than in the '-' line when pooled for the period 1990-1992 (0.515 vs. 0.425). This improvement in multiple births was accomplished without a reduction in lamb survival, which was higher ( $P \leq 0.10$ ) in '+' line lambs than in '-' line lambs over the same period (0.776 vs. 0.712). When percentage deviations for Lw/Ej in '+' line ewes from contemporaries in the '-' line were regressed on lambing year, an increase of 11.6 ( $R^2 = 0.87$ ) % per year was found. A large portion of this improvement was attributed to a change in flock structure through the replacement of unselected ewes by selected young ewes in the two breeding flocks.

Twee Merinolyne is in 1988 daargestel en aan uiteenlopende seleksie op maternale rangordes vir lammers gespeen/ooi gepaar (Ls/Op) onderwerp. In die Reproduksie '+'-lyn is vervangingsdiere met hoë rangordesysfers geselekteer, terwyl nageslag van ooië met lae rangordes in die Reproduksie '-'-lyn verkies is. Ooië gelang/ooi gepaar was hoër ( $P \leq 0.10$ ) in die '+'-lyn as in die '-'-lyn gedurende 1989, 1991 en 1992. Die proporsie meerlinglammers in die '+'-lyn was hoër ( $P \leq 0.05$ ) as in die '-'-lyn oor die tydperk 1990-1992 (0.515 vs. 0.425). Dié toename in meerlinggeboortes is teweeggebring sonder 'n afname in lamoorlewing (Ls/Lb). In werklikheid was Ls/Lb hoër ( $P \leq 0.10$ ) in die '+'-lyn as in die '-'-lyn oor dieselfde periode (0.776 vs. 0.712). Die regressie van persentasie afwykings van '+'-lyn ooië van '-'-lyn tydgenote ten opsigte van Ls/Op op lamjaar het op 'n toename van 11.6 ( $R^2 = 0.87$ ) % per jaar gedui. Dié verbetering is grootliks toegeskryf aan 'n verandering in kuddestruktuur deur die verplasing van ongeselekteerde ooië met geselekteerde jongooie in die teelkuddes.

**Keywords:** Divergent selection, lambs weaned, overall reproduction.

A low reproduction rate is considered to be a limitation in the local Merino industry. De Klerk *et al.* (1983) reported that lambs born per ewe joined was found to be 71% on average in the national flock. In the Bredasdorp district, which has a high potential for sheep production, roughly a quarter of joined ewes fail to rear a lamb to lamb marking at approximately 6 weeks (Fourie & Cloete, 1993). There thus appears to be ample scope for improvement in the industry.

In the past, selection recommendations for reproduction involved selection for twinning rather than other component traits and the composite trait, lambs weaned per ewe joined. Responses in twinning were reported for Merinos (Turner, 1978) and other breeds (Clarke, 1972; Hanrahan, 1984; Burfening *et al.*, 1989). Prewaning lamb losses were also reported to respond to selection in Merinos (Donnelly, 1982; Haughey, 1983). It is clear that selection experiments which involve reproduction, concentrated on component traits rather than number of lambs or mass of lamb weaned per ewe joined, which is the true breeding objective. Luxford & Beilharz (1987) and Delpont (1989) argued that selection for reproduction should be based on a criterion closely resembling the true breeding objective.

The influence of divergent selection based on maternal ranking values for lambs weaned per ewe joined (Lw/Ej) was thus investigated in Merino ewes over the period 1988-1992. The experimental site was Langgewens experimental farm, which is situated in the winter cereal cropping region of the Swartland. The long-term, average precipitation on the experimental site is 395 mm per year, of which 78% is expected in the period April to September. Oaten stubble which was allowed to proceed to fallow lands was the most important source of nutrition up to 1990. During 1991 and 1992 annual medic (*Medicago truncatula*) were also utilized.

The experimental animals were of a mixed age (2-6 years), commercial Merino flock, numbering 225 ewes. These ewes were flock-mated to seven rams selected at random from the Tygerhoek Selection and Control lines (Heydenrych *et al.*, 1984) in November 1987. Before joining in 1988, these ewes were stratified according to age and randomly allocated to two equal experimental groups within age classes of 3-6 years. These groups were termed the Reproduction '+' and Reproduction '-' lines. Two-year-old replacement ewes in the respective lines were selected on high and low maternal ranking values for Lw/Ej. Ranking values were derived as suggested by Turner (1977), using the following formula:

$$(\hat{G} - \bar{G}_O) = 0.5 h^2 \frac{k}{1 + (k-1)t} (\bar{P}_D - \bar{P}_D)$$

with  $(\hat{G} - \bar{G}_O)$  = the ranking value for an individual under selection,

$h^2$  = heritability of number of lambs weaned per joining, taken as 0.14 (Cloete, 1986),

$t$  = repeatability of number of lambs weaned per joining, taken as 0.14 (Cloete, 1986),

$k$  = number of times the dam of the individual has been joined,

$\bar{P}_D$  =  $K/k$ , with  $K$  the total number of lambs weaned to the dam, and

$\bar{P}_D$  = the mean number of lambs weaned per joining for the flock under consideration, for ewes up to and including the dam's present age.

The ranking values were derived from lambs reared to lamb marking, but for ease of discussion, and because of the low incidence of lamb mortalities after lamb marking, the term 'lambs weaned' will be used throughout. Both lines were flock-mated to eight rams selected on maternal ranking from the Tygerhoek Selection and Control lines. Subsequent selection of replacements of both sexes was done on the same basis. Generally, replacements in the '+' line were descended from ewes that weaned > 1 lamb/joining (i.e. weaned twins at least once), while contemporaries in the '-' line were progeny of ewes that weaned < 1 lamb/joining (i.e. failed to rear a lamb at least once). Rams were used for one breeding season only, whereas ewes were retained to an age of 6 years in the respective lines, except in case of death or severe udder damage. During 1991 and 1992 single sire matings with four rams were practised in both lines to replace the system of flock-mating used earlier. During these years, both lines were split into two groups, which lambed in autumn (April/May) or winter (July/August), respectively. Season of lambing did not influence conclusions, and will be ignored in subsequent discussions.

Production data of individual ewes were recorded annually. The components of overall reproduction, viz. ewes lambed/ewe joined (El/Ej), ewes lambing multiples/ewe lambed (Elm/El) and lambs weaned/lamb born (Lw/Lb) were expressed as proportions and tested for significance between

lines using chi-square ( $\chi^2$ ) methods (Snedecor & Cochran, 1967). The method described by Brown (1988), also based on the  $\chi^2$  distribution, was used to compare Lw/Ej between lines. Because of the relatively small numbers involved in some analyses, tendencies at a significance level of  $P < 0.25$  are noted in the text, while a level of  $P < 0.10$  was regarded as significant.

In 1988, prior to the commencement of selection, there was a tendency ( $P = 0.21$ ) towards a higher level of Elm/El in the '+' line (Table 1). It was, however, cancelled by an opposite tendency ( $P = 0.13$ ) in Lw/Lb. In subsequent years, there was a clear indication of divergence between the lines in Lw/Ej with significant ( $P \leq 0.05$ ) line differences in 1991 and 1992. This could be attributed to an advantage ( $P \leq 0.10$ ) in El/Ej in the '+' line for 1989, 1991 and 1992. In 1991, corresponding tendencies ( $P \leq 0.24$ ) were observed for Elm/El and Lw/Lb. The proportion of multiple lambs born over the period 1990–1992 in the '+' line was higher ( $P \leq 0.05$ ) than in the '-' line (0.515 vs. 0.425;  $\chi^2 = 5.15$ ). It is notable that Lw/Lb was also improved ( $P \leq 0.10$ ) in '+' line progeny compared to '-' line contemporaries (0.776 vs. 0.712;  $\chi^2 = 2.99$ ), despite the higher proportion of multiple lambs in the former line.

The divergence in Lw/Ej is clearly illustrated in Figure 1. Average annual performance in terms of Lw/Ej in the '+' line was also expressed as percentage deviations from the '-' line

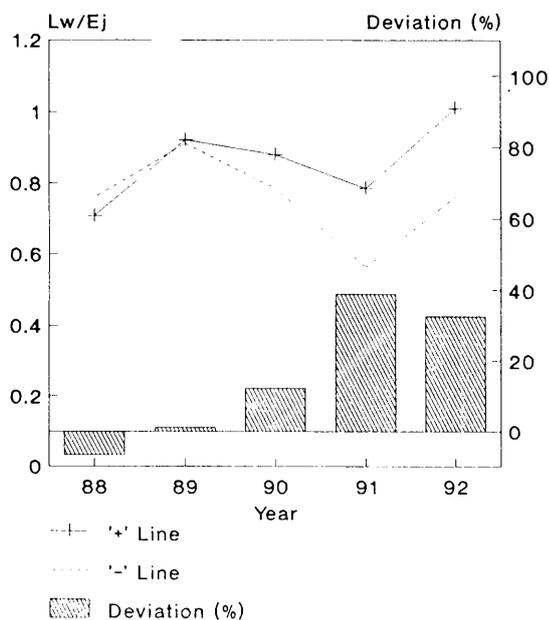
**Table 1** Mean annual reproductive performance of ewes in the Reproduction '+' and Reproduction '-' lines at Langgewens for the period 1988–1992

Year and line	Ewes lambing			
	Ewes lambed/ Ewe joined El/Ej	multiples/ Ewe lambed Elm/El	Lambs weaned/ Lamb born Lw/Lb	Lambs weaned/ Ewe joined Lw/Ej
<b>1988</b>				
'+'	0.894 (113) <sup>a</sup>	0.277 (101)	0.620 (129)	0.708
'-'	0.884 (112)	0.192 (99)	0.720 (118)	0.759
$\chi^2$	NS	1.58	2.36	NS
<b>1989</b>				
'+'	0.947 (114)	0.222 (108)	0.795 (132)	0.921
'-'	0.866 (112)	0.247 (97)	0.843 (121)	0.911
$\chi^2$	3.51*	NS	NS	NS
<b>1990</b>				
'+'	0.907 (108)	0.316 (98)	0.736 (129)	0.880
'-'	0.902 (102)	0.286 (66)	0.678 (118)	0.784
$\chi^2$	NS	NS	NS	NS
<b>1991</b>				
'+'	0.841 (107)	0.344 (90)	0.694 (121)	0.785
'-'	0.741 (108)	0.250 (80)	0.594 (101)	0.565
$\chi^2$	2.69*	1.38	2.00	8.07**
<b>1992</b>				
'+'	0.811 (111)	0.378 (90)	0.896 (125)	1.009
'-'	0.642 (109)	0.286 (70)	0.883 (94)	0.761
$\chi^2$	7.1**	NS	NS	6.36**

<sup>a</sup> Numbers of ewes joined, ewes lambed and lambs born are given in parentheses.

\* Significant ( $P \leq 0.10$ ).

\*\* Significant ( $P \leq 0.05$ ).



**Figure 1** Yearly mean figures for lambs weaned/ewe joined (Lw/Ej) in the '+' and '-' lines, and percentage deviations of '+' line ewes from '-' line contemporaries within years.

(Figure 1), and regressed on lambing year. A linear increase, amounting to 11.6 ( $R^2 = 0.873$ ) % per year was observed. This enhancement could hardly be attributed to genetic improvement solely. A large portion of it seemed to stem from a change in flock structure through the replacement of unselected ewes in the two breeding flocks by selected young ewes.

It is clearly impossible to obtain an indication of genetic gain in Lw/Ej from the present analysis. Reasonably accurate indications of the lifetime reproduction of individuals entering the two breeding flocks in later generations are required for this purpose. There is, however, little doubt that selective breeding caused the observed divergence in Lw/Ej between the '+' and '-' lines. Since El/Ej is a function of both male and female reproductive fitness, more attention is required to this component of Lw/Lj. Figures for El/Ej for rams in the '-' line were compared statistically to determine whether poor mating performance by one ram largely contributed to the line differences for 1991 and 1992. Significant ram differences were observed during 1991 ( $\chi^2 = 19.96$ ; df. = 3). In this year, one ram had 0.393 El/Ej which was poorer ( $P \leq 0.05$ ) than two contemporaries ( $\geq 0.840$ ). A similar tendency ( $P = 0.10$ ) was observed in 1992, but no differences approaching significance were observed between rams after the Bonferroni correction. All rams were tested fertile, but since no detailed observations were carried out during joining, it is uncertain whether these results were due to poor libido or poor mating dexterity. Male reproductive performance is currently being studied in the two lines.

It is noteworthy that the improvement in Elm/El was accomplished without a significant reduction in Lw/Lb. Under field conditions, much of the potential improvement of Lw/Ej by selection for increased litter size is lost due to low lamb survival levels of multiples (Fogarty & Hall, 1987). Atkins (1980) found that selection for multiple birth rate as well as against barrenness and rearing failure in the 'Fertility Flock' at

Trangie resulted in a substantial improvement of 36% in Lw/Ej relative to an unselected control flock. This was accomplished by a marked improvement in Elm/El, while moderate improvements were recorded for El/Ej and Lw/Lb. This study accordingly suggests that selective breeding of sheep for a composite trait like Lw/Ej results in enhanced performance levels.

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