Comparison of productive and reproductive efficiency of Afrino, Dorper and Merino sheep in the False Upper Karoo

M.A. Snyman[#] and M.J. Herselman
Grootfontein Agricultural Development Institute, Private Bag X529, Middelburg (EC) 5900, South Africa

Abstract

The productive and reproductive performance of, as well as income generated by Afrino, Dorper and Merino sheep at two localities in the False Upper Karoo region were evaluated. A total of 1242 ewe reproductive records was available, while data of respectively 772 and 405 lambs were analysed for the growth traits and slaughter traits. Percentage of lambs weaned per ewe in the flock was 132.0%, 100.0% and 93.7% for Afrino, Dorper and Merino ewes at Grootvlei, respectively. Corresponding values for Twistkraal were 153.3%, 114.7% and 96.4%, respectively. Body weights of 52.3 ± 1.4 kg, 56.6 ± 1.4 kg and 43.4 ± 1.4 kg were recorded for Afrino, Dorper and Merino ewes, respectively. Merino ewes produced on average 1.3 kg more clean wool, of a 0.6 µm stronger diameter than Afrino ewes. At each locality Dorper lambs were the heaviest at weaning, followed by Afrino and then by the Merino lambs. Dorper lambs were slaughtered earlier than Afrino lambs, with Merino lambs taking the longest interval to reach slaughter weight. A definite seasonal effect was also evident, where the autumn-born lambs reached slaughter weight earlier than spring-born lambs in all breeds. With the current wool and mutton prices, Afrino sheep had the highest gross income per ewe, followed by Merino and Dorper ewes respectively. However, Merino sheep had the highest gross income per hectare at both localities, followed by Afrino and then Dorper sheep. The combination of low ewe body weights, high wool production and a relatively high reproductive rate, resulted in Merino sheep generating the highest income per hectare, compared to Afrino and Dorper sheep. Reproductive rate, mature body weight and fibre production are the primary factors determining profitability of a specific sheep enterprise. These parameters should thus be considered when changing from one breed or commodity to another.

Keywords: Body weight, wool production, slaughter traits, income
[#] Corresponding author. E-mail: grethas@gfn.agric.za

Introduction

The difference in profitability of sheep breeds remains one of the most controversial issues among sheep producers. However, very little research has been done in this field on South African sheep breeds (Fourie & Cloete, 1993; Schoeman *et al*., 1995; Snyman *et al*., 2000; Cloete *et al*., 2004a; Cloete *et al*., 2004b). The reason for this is that the full implication of breed comparisons is seldom taken into account. Nonetheless, farmers are continuously changing from one breed to another. The decision to change from one breed to another is mostly due to short-term financial reasons and current trends that favour either wool or meat.

The issue of less selective grazing behaviour of Dorper sheep is frequently mentioned. Research results in various areas in the Karoo have shown that there are very little differences in grazing behaviour and diet selection of different sheep breeds (Botha *et al*., 1983; Du Toit *et al*., 1994; Du Toit, 2000). In a study conducted on Eastern Mixed Karoo veld (Middelburg district) with Merino and Dorper sheep over several seasons, it was found that there was a 97 %, 92%, 75% and 97% overlap in diets selected by the two breeds during the winter, spring, summer and autumn seasons, respectively (Du Toit, 1998).

Another aspect of breed comparisons, which could contribute to wrong conclusions, is the inaccurate large stock unit (LSU) values assigned to various small stock breeds by the Act on the Conservation of Agricultural Resources (Act 43 of 1983) (Department of Agricultural Economics and Marketing, 1985). If these LSU-values are used for the purpose of breed comparison, income per hectare of mutton sheep tends to be over-estimated relative to that of wool sheep. Furthermore, if ewe numbers are based on current legislation when changing from wool to mutton sheep, the natural vegetation will suffer due to an over-estimation of Dorper ewe numbers

(Herselman, 2000).

Relatively small differences in income between Afrino, Dorper and Merino sheep have been reported in both the Arid Karoo (Carnarvon district) and the False Upper Karoo (Hofmeyr district) (Snyman *et al*., 2000). However, relatively large differences in production were reported between the different localities for all three sheep breeds. The two localities were very divergent with regard to climate and vegetation. The average annual rainfall for the Carnarvon area is 211 mm with a grazing capacity of 37 ha/LSU, whereas Hofmeyr has an average annual rainfall of 360 mm and a grazing capacity of 12 ha/LSU. Despite the aforementioned report indicating relatively small differences in income from different sheep breeds, various producers still raised their concern with regard to the influence of topography and veld type on breed choice in a specific ecological zone. Furthermore, the experimental layout of the above-mentioned study was such that all available ewes in the flock were mated every six months. This places some limitations on the extrapolation of these results to other farms.

A study was therefore conducted to investigate the relative performance of different sheep breeds in two different topographic/veld types, on the same farming enterprise in the Middelburg district of the Eastern Cape Province.

Material and Methods

The study was conducted at Grootvlei and Twistkraal in the Middelburg district in the Eastern Cape Province under natural conditions. The veld type is classified as False Upper Karoo (Veld type 36; Acocks, 1988). One part of the farming enterprise, namely, Grootvlei, is characterized by typical "Vlakte"-veld, which is normally regarded as a better veld type than the mountainous veld which was the predominant veld type of Twistkraal, the other part of the farming enterprise. At the time Grootvlei was utilized for Dorper farming and Twistkraal for Merino farming. Apart from Merino (wool breed) and Dorper (meat breed) sheep, which were already run on Twistkraal and Grootvlei, respectively, Afrino (dual-purpose) sheep were also included for the purpose of this study.

From April 2001 to July 2003, Afrino, Dorper and Merino ewe flocks, consisting of ±100 ewes each, were kept at both Grootvlei and Twistkraal. During January and February 2001, 100 Merino ewes, as well as 100 Dorper ewes were bought from farmers in the Middelburg and adjacent areas. The rest of the Merino and Dorper ewes were obtained from the existing flocks at Twistkraal and Grootvlei. Afrino ewes were bought from different breeders. All ewes were tagged with an identity number after they were bought and shorn at the end of February 2001 to ensure that all ewes had the same wool growth period before recording wool traits.

Afrino rams were bought on the Afrino ram sales, while Merino and Dorper rams available at Twistkraal and Grootvlei respectively, were used in the Merino and Dorper flocks. The ewes of all three breeds were managed as one flock at each location for the duration of the study, except during mating. Lambs were also run together and managed as one flock. Animals were kept under a set stock grazing system (16 ha/LSU) natural veld conditions and received no feed or mineral supplementation at any stage. The normal inoculation, drenching and tick control programs were followed.

Ewes originating from the different farmers were divided equally between Grootvlei and Twistkraal in such a way that the two flocks had a similar age structure. Ewe ages ranged from two to five years in all sub-groups. A system of two breeding seasons per year was followed. At the start of the experiment, 50 ewes of each breed were mated at each locality to 4% rams for a seven-week period from April to June 2001. All rams were tested for fertility before mating started. The second breeding season stretched from 15 October to 25 November 2001. Ewes mated at each locality included all ewes that did not lamb during September 2001, as well as an additional 50 Afrino ewes bought from breeders and 50 Merino and 50 Dorper ewes from the existing flocks at Twistkraal and Grootvlei. This mating system was followed until the March 2003-lambing season.

The following data were recorded for each lambing season on a daily basis: dam ID, lamb ID, date of birth, sex and birth status of the lamb. Furthermore, weaning weight, as well as monthly body weight of lambs from five to 10 months of age were recorded. At six months of age, all ewe lambs were classed and those not suitable for replacement purposes were declared surplus. Replacement ewe lambs were selected according to breed standards. Afrino and Merino lambs were shorn at six months of age. All lambs were weighed monthly and the surplus ewe lambs, together with all the ram lambs, were slaughtered at the local abattoir as soon as they had reached slaughter weight (± 40 kg for Dorper lambs; ± 42 kg for Afrino and Merino lambs). All Afrino and

Merino lambs with more than six months' wool growth, were shorn before slaughtering. Upon reaching slaughter weight, lambs were fasted overnight and fasted body weight was recorded before slaughtering the next morning. Carcass weight, dressing percentage, V1 (fat depth measured with a calliper at a site 2.5 mm lateral to the 3rd sacral vertebrae) and V3 (fat depth measured with a calliper at a site 2.5 mm lateral to the 3rd lumbar vertebrae) and carcass grading were recorded.

Body weight of ewes was recorded before each mating season. Afrino and Merino ewes were shorn at the end of January 2002 and 2003. Fleece weight was recorded after shearing and a midrib wool sample was taken from each ewe for determination of fibre diameter, clean yield percentage, staple length, crimp frequency, Duerden, coefficient of variation and standard deviation of fibre diameter.

Data collected on the ewe flock for four lambing seasons (from September 2001 to March 2003) included records on number of ewes mated, number of ewes that lambed, number of lambs born and number of lambs weaned. A total of 1242 reproductive records was available for the three breeds at the two localities. As some of the Dorper ewes lambed outside the lambing seasons, reproductive data collected during the experimental period were pooled, and the average performance per ewe in the flock for the experimental period was calculated. Reproductive performance was also expressed on a year basis. Differences between breeds with regard to the percentage of lambs born per ewe in the flock, survival rate of lambs from birth till weaning and percentage of lambs weaned per ewe in the flock, were tested for significance employing the chi-square procedure of SAS (1996).

Body weight records of a total of 395 Afrino, 422 Dorper and 401 Merino ewes were available. These, as well as the wool production data recorded on 403 Afrino and 381 Merino ewes in 2002 and 2003 were analysed with least-squares procedures (Littell *et al.*, 1991; SAS, 1996). The following mathematical model was used:

$$Y_{ijklm} = \mu + ys_i + b_j + l_k + a_l + (bl)_{jk} + e_{ijklm}$$

Where:

Y_{ijklm} = trait of the m'th animal of the l'th age of the k'th locality of the j'th breed of the i'th year

μ = overall mean,

ys_i = fixed effect of the i'th year (20012, 20021, 20022, 20031 for body weight; 2002, 2003 for wool traits),

b_j = fixed effect of the j'th breed (Afrino, Dorper, Merino for body weight; Afrino, Merino for wool traits),

l_k = fixed effect of the k'th locality (Grootvlei, Twistkraal),

a_l = fixed effect of the l'th age of ewe (2, 3, 4, 5, 6 years),

$(bl)_{jk}$ = effect of the interaction between the j'th breed and the k'th locality,

e_{ijklm} = random error with zero mean and variance $I\sigma^2_e$

Fixed effects, which contributed significantly to variance of the different traits, are summarised in Table 1. Only significant effects were included in the final models fitted.

Growth and slaughter traits analysed for the lambs are summarised in Table 1. Data from 772 and 405 lambs were analysed for the growth and slaughter traits, respectively. For body weight from weaning until seven months of age, body weights of all lambs were included, i.e. surplus as well as selected lambs. From eight months of age, body weight data for surplus ram and ewe lambs not yet slaughtered, as well as the selected ewe lambs were included. As the lambs were slaughtered at a predetermined body weight, slaughter weight was included as a covariate in the analyses for slaughter traits. Least-squares procedures (SAS, 1996) were used to analyse data for all growth and slaughter traits (Littell *et al.*, 1991). The following mathematical model was used:

$$Y_{ijklmno} = \mu + ys_i + b_j + l_k + s_l + r_m + a_n + (bl)_{jk} + b_1AL + b_2SW + e_{ijklmno}$$

Where:

$Y_{ijklmno}$ = trait of the o'th animal of the n'th dam age of the m'th rearing status of the l'th sex of the k'th locality of the j'th breed of the i'th birth year-season,

μ = overall mean,

ys_i = fixed effect of the i'th birth year-season (20012, 20021, 20022, 20031),

b_j = fixed effect of the j'th breed (Afrino, Dorper, Merino),

l_k = fixed effect of the k'th locality (Grootvlei, Twistkraal),

s_l = fixed effect of the l'th sex (rams, ewes),
r_m = fixed effect of the m'th rearing status (11, 21, 22, 31, 32, 33),
a_n = fixed effect of the n'th age of dam (2, 3, 4, 5, 6 years),
$(bl)_{jk}$ = effect of the interaction between the j'th breed and the k'th locality,
b_1 = linear regression coefficient of the appropriate deviation from the mean of age of the lamb at recording (AL – fitted only for growth traits),
b_2 = linear regression coefficient of the appropriate deviation from the mean of slaughter body weight (SW - fitted only for all the slaughter traits – see Table 1) and
$e_{ijklmno}$ = random error with zero mean and variance $I\sigma^2_e$

Table 1 Fixed effects included in the models fitted for the various traits analysed

Trait	Locality	Year-Season	Breed	Sex	Rearing status	Age of dam	Age of animal	Locality x Breed
Growth traits of lambs								
Weaning weight (kg)	*	**	**	**	**	ns	**	ns
Average daily gain : birth to weaning (g/day)	ns	**	**	**	**	ns		ns
6 mo weight (kg)	**	**	**	ns	**	ns	**	ns
7 mo weight (kg)	**	**	**	ns	**	ns	**	ns
8 mo weight (kg)	**	**	**	*	**	ns	**	ns
9 mo weight (kg)	**	**	**	ns	**	ns	**	*
10 mo weight (kg)	**	**	**	ns	**	ns	**	*
Slaughter traits of lambs								
Slaughter weight (kg)	ns	**	**	ns	*	ns		ns
Slaughter age (days)	*	**	**	**	*	ns		ns
Carcass weight (kg)	ns	**	**	ns	ns	ns		*
Dressing %	ns	**	*	ns	ns	ns		*
V1 (mm)	ns	**	ns	**	ns	ns		ns
V3 (mm)	*	**	ns	*	ns	ns		*
Body weight and wool production of ewes								
Body weight (kg)	*	**	**				**	ns
Greasy fleece weight (kg)	**	**	**				**	ns
Clean fleece weight (kg)	**	*	**				**	ns
Clean yield (%)	ns	ns	**				**	ns
Fibre diameter (µm)	**	**	**				**	ns
CF (%)	ns	**	**				**	ns
SD (µm)	ns	**	ns				**	ns
CV (%)	ns	**	ns				**	ns
Staple length (mm)	**	**	**				**	ns
Crimp frequency	*	**	**				*	ns
Duerden	**	**	**				**	ns

V1 - fat depth measured with a calliper at a site 2.5 mm lateral to the 3rd sacral vertebrae
V3 - fat depth measured with a calliper at a site 2.5 mm lateral to the 3rd lumbar vertebrae
CF - crimp frequency; CV - coefficient of variation; SD- standard deviation of fibre diameter
* = $P < 0.05$; ** = $P < 0.01$; ns = not significant

Production norms recorded during the study were used to calculate gross income for the three breeds at the two localities. The SM2000-programme of Herselman (2002b) was used for the analyses. Various product price scenarios were used to calculate income generated by the three breeds. For all the calculations, actual body weights of animals were used to calculate LSU-values (Herselman, 2002a). The following inputs were required: number of lambs born per ewe available, body weight at birth, weaning and 12 months of age, adult ewe body weight, mortality rate from birth to weaning and in young and older sheep, Slaughter weight and age, dressing percentage, meat prices, prices of skin, head and trotters, marketing cost, wool production of ewes and lambs, wool prices, wool marketing cost and animal health cost.

Results and Discussion

Fixed effects, which contributed significantly to variance of the different traits, are summarised in Table 1. Only significant effects were included in the final models fitted.

The reproductive performance for the three breeds at Grootvlei and Twistkraal over the experimental period is summarised in Table 2. Reproductive performance recorded in this study falls within the ranges reported in literature for the specific breeds (Snyman *et al*., 1993; Cloete *et al*., 2000; Snyman *et al*., 2000; Olivier *et al*., 2002; Snyman & Olivier, 2002).

Body weights of ewes recorded before each mating season are summarised in Table 3 for the three breeds at the two localities. Body weight of ewes before mating was higher at Grootvlei than at Twistkraal, while Dorper ewes were heavier than Afrino ewes, which in turn were heavier than Merino ewes. Afrino ewes in this study had lower body weights than those recorded for Afrino sheep at Carnarvon (60.0 to 64.7 kg) and Tarka (66.4 kg) (Snyman *et al*., 1993; Snyman *et al*., 2000). Body weight of Dorper ewes at Grootvlei and Twistkraal also falls within the lower ranges of 50.0 kg to 74.0 kg cited in the literature (Cloete *et al*., 2000; Snyman *et al*., 2000; Snyman & Olivier, 2002). Merino ewes in this study also weighed less than reported body weights in literature (Snyman *et al*., 2000; Olivier *et al*., 2002).

Table 2 Reproductive performance of Afrino, Dorper and Merino ewes at Grootvlei and Twistkraal over the experimental period

Trait	Grootvlei			Twistkraal		
	Afrino	Dorper	Merino	Afrino	Dorper	Merino
Number of ewes in the flock	128	137	158	122	116	138
Number of matings	207	225	213	192	187	189
Number of lambs born	194	178	174	205	162	147
Number of lambs weaned	169	137	148	187	133	133
Lambs born per 100 ewes in the flock (%)	151.6[a]	129.9[b]	110.1[a b]	168.0[a b]	139.7[b]	106.5[a]
Lambs weaned per 100 ewes in the flock (%)	132.0[a]	100.0[a]	93.7[a]	153.3[a b]	114.7[b]	96.4[a]
Lambs weaned per 100 lambs born (%)	87.1	77.0	85.1	91.2[a]	82.1[a b]	90.5[b]
Ave number of matings per ewe in the flock	1.6	1.6	1.3	1.6	1.6	1.4

[a b] Values with the same superscript differ ($P < 0.05$) between breeds at the same locality

Table 3 Least square means for body weight (± s.e.) of Afrino, Dorper and Merino ewes before mating at Grootvlei and Twistkraal

Breed	Grootvlei (kg)	Twistkraal (kg)	Average / Breed (kg)
Average / Locality (kg)	51.7 ± 1.3[a]	49.9 ± 1.3[a]	
Afrino	52.7 ± 1.5	52.0 ± 1.6	52.3 ± 1.4[b]
Dorper	57.8 ± 1.6	55.4 ± 1.6	56.6 ± 1.4[b]
Merino	44.6 ± 1.6	42.2 ± 1.6	43.4 ± 1.4[b]

[a] = Values within the same row with the same superscripts differ significantly ($P < 0.05$) between localities
[b] = Values within the same row with the same superscripts differ significantly ($P < 0.05$) between breeds

Wool production is summarised in Table 4. Merino ewes produced on average 1.3 kg more clean wool, of a 0.6 µm stronger diameter, than Afrino ewes. From Table 4 it is clear that both Afrino and Merino ewes at Grootvlei produced less wool with a lower fibre diameter than the ewes at Twistkraal. Wool production as well as fibre diameter of Afrino and Merino ewes at Grootvlei and Twistkraal were lower than those recorded in other studies under similar conditions (Snyman *et al.*, 1993; Snyman *et al.*, 2000; Olivier *et al.*, 2002).

Table 4 Least square means for wool production traits (± s.e.) of Afrino and Merino ewes at Grootvlei and Twistkraal

Trait	Grootvlei		Twistkraal	
	Afrino	Merino	Afrino	Merino
Greasy fleece weight (kg)	1.74 ± 0.06[a b]	3.43 ± 0.07[a b]	1.92 ± 0.06[a b]	3.67 ± 0.07[a b]
Clean fleece weight (kg)	1.15 ± 0.05[a b]	2.47 ± 0.05[a]	1.26 ± 0.05[a b]	2.68 ± 0.05[a b]
Clean yield (%)	65.6 ± 0.6[a]	72.9 ± 0.7[a b]	65.6 ± 0.6[a]	74.0 ± 0.7[a]
Fibre diameter (µm)	20.1 ± 0.2[a b]	20.7 ± 0.2[a b]	20.6 ± 0.2[a b]	21.2 ± 0.2[a b]
CF (%)	97.8 ± 0.3	97.2 ± 0.4	97.6 ± 0.3[a]	96.7 ± 0.3[a]
SD (µm)	4.1 ± 0.1	4.1 ± 0.1	4.1 ± 0.1	4.2 ± 0.1
CV (%)	20.2 ±0.3	19.9 ± 0.3	19.8 ± 0.3	19.8 ± 0.3
Staple length (mm)	64.0 ± 1.6[a b]	83.1 ± 1.8[a b]	70.2 ± 1.5[a b]	89.3 ± 1.7[a b]
Crimp frequency	14.8 ± 0.3[a]	12.8 ± 0.3[a b]	14.6 ± 0.3[a]	12.2 ± 0.3[a b]
Duerden	101.5 ± 1.4[a b]	97.2 ± 1.6[a b]	108.2 ± 1.3[a b]	101.2 ± 1.5[a b]

CF - crimp frequency; CV - coefficient of variation; SD - standard deviation of fibre diameter
[a] Values within the same row with the same superscript differ ($P < 0.05$) between breeds at the same locality
[b] Values within the same row with the same superscript differ ($P < 0.05$) between localities for the same breed

Growth performance of the lambs is presented in Table 5. Dorper lambs were the heaviest at weaning, followed by Afrino and then the Merino lambs at each locality. The same tendency was observed for 6- to 9-month body weights at Twistkraal. At Grootvlei there were no differences in 6- to 10-month body weights between Dorper and Afrino lambs, both being heavier than the Merino lambs ($P < 0.05$). A significant locality effect was observed for all body weights recorded, where lambs at Grootvlei were heavier than those at Twistkraal. Growth performance of lambs accords well with those cited in literature for the three breeds (Snyman *et al.*, 1995; Cloete *et al.*, 2000; Snyman *et al.*, 2000; Olivier *et al.*, 2002; Snyman & Olivier, 2002).

Table 5 Least square means for body weight (± s.e.) of Afrino, Dorper and Merino lambs at Grootvlei and Twistkraal

Trait	Grootvlei			Twistkraal		
	Afrino (n = 147)	Dorper (n = 103)	Merino (n = 135)	Afrino (n = 145)	Dorper (n = 113)	Merino (n = 129)
Weaning weight (kg)	28.1 ± 1.2[a]	31.0 ± 1.3[a]	22.1 ± 1.2[a]	26.9 ± 1.2[a]	30.7 ± 1.1[a]	21.3 ± 1.2[a]
Average daily gain: birth to weaning (g/day)	251 ± 2.6[a]	280 ± 13.6[a]	193 ± 13.0[a]	240 ± 12.6[a]	284 ± 12.1[a]	183 ± 13.1[a]
6 mo weight (kg)	32.9 ± 1.2[a]	34.7 ± 2.0[b]	26.1 ± 1.6[a b]	28.8 ± 1.5[a]	33.7 ± 1.9[a]	23.9 ± 1.6[a]
7 mo weight (kg)	37.6 ± 1.3[a]	39.6 ± 2.1[b]	31.2 ± 1.7[a b]	34.3 ± 1.6[a]	37.5 ± 1.9[a]	29.8 ± 1.6[a]
8 mo weight (kg)	40.6 ± 1.3[a]	42.2 ± 2.1[b]	33.1 ± 1.7[a b]	34.6 ± 1.6[a]	39.3 ± 1.9[a]	30.0 ± 1.6[a]
9 mo weight (kg)	43.4 ± 1.3[a]	43.7 ± 2.0[b]	34.8 ± 1.6[a b]	37.2 ± 1.5[a]	41.3 ± 1.9[a]	33.1 ± 1.6[a]
10 mo weight (kg)	45.4 ± 1.3[a]	44.8 ± 2.1[b]	36.1 ± 1.7[a b]	39.8 ± 1.6[a]	42.5 ± 2.0[b]	34.5 ± 1.7[a b]

[a b] Values within the same row with the same superscript differ ($P < 0.05$) between breeds at the same locality
n - number of lambs weaned

Slaughter traits for the lambs are summarised in Table 6. From Table 6 it is evident that Dorper lambs reached slaughter age earlier than Afrino and Merino lambs. Afrino and Dorper lambs in this study were slaughtered at a higher average age than the ranges recorded in literature (Badenhorst *et al*., 1992; Snyman *et al*., 1993; Cloete *et al*., 2000; Snyman *et al*., 2000; Snyman & Olivier, 2002). However, differences in slaughter age could most probably be ascribed to differences in slaughter weight, as is clearly illustrated in the different values cited in the review of Cloete *et al*. (2000). Other carcass traits fall within the ranges reported in the literature.

Table 6 Least square means for slaughter traits (± s.e.) of Afrino, Dorper and Merino lambs at Grootvlei and Twistkraal

Trait	Grootvlei			Twistkraal		
	Afrino (n = 93)	Dorper (n = 73)	Merino (n = 44)	Afrino (n = 74)	Dorper (n = 60)	Merino (n = 61)
Slaughter weight (kg)	42.9 ± 0.7[a]	40.9 ± 0.8[a]	42.0 ± 0.8	42.1 ± 0.7[a]	39.2 ± 0.7[a b]	42.3 ± 0.7[b]
Slaughter age (days)	268 ± 9.2[a]	248 ± 11.1[a]	337 ± 11.2[a]	295 ± 9.6[a]	236 ± 9.9[a]	348 ± 10.3[a]
Carcass weight (kg)	18.8 ± 0.2	19.0 ± 0.3	19.6 ± 0.3	19.3 ± 0.2[a]	19.2 ± 0.2[a]	18.5 ± 0.2[a]
Dressing %	45.4 ± 0.8	45.5 ± 1.0	44.8 ± 1.0	46.5 ± 0.8[a]	46.8 ± 0.9[b]	44.5 ± 0.9[a b]
V1 (mm)	3.7 ± 0.4	3.5 ± 0.5	3.4 ± 0.5	4.4 ± 0.4[a]	4.0 ± 0.4[b]	3.8 ± 0.4[a b]
V3 (mm)	2.7 ± 0.3[a]	2.3 ± 0.3	1.8 ± 0.3[a]	3.0 ± 0.3[a]	2.4 ± 0.3[a]	2.9 ± 0.3

V1 - fat depth measured with a calliper at a site 2.5 mm lateral to the 3rd sacral vertebrae
V3 - fat depth measured with a calliper at a site 2.5 mm lateral to the 3rd lumbar vertebrae
[a b] Values within the same row with the same superscript differ ($P < 0.05$) between breeds at the same locality
n - number of lambs slaughtered

The cumulative percentage of lambs slaughtered for each breed is depicted in Figures 1 and 2 for the

September- and March-born lambs respectively. From these figures it is also evident that Dorper lambs were slaughtered earlier than Afrino lambs, with Merino lambs taking the longest time to reach slaughter weight. A definite seasonal effect is also evident from Figures 1 and 2, where the autumn-born lambs (Figure 2) reached slaughter weight earlier than spring-born lambs (Figure 1).

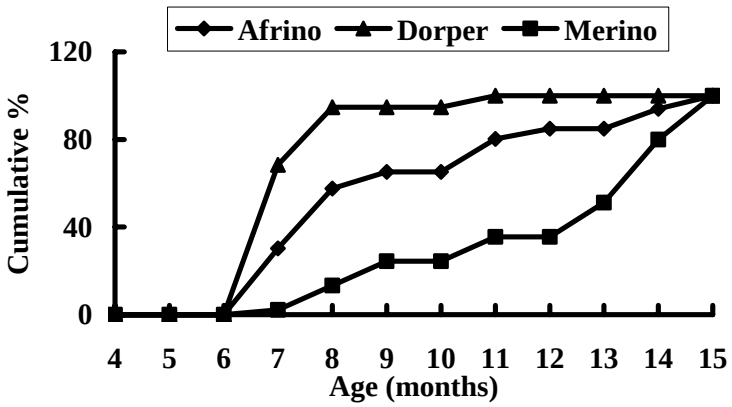

Figure 1 Cumulative percentage September-born Afrino, Dorper and Merino lambs slaughtered at both Grootvlei and Twistkraal

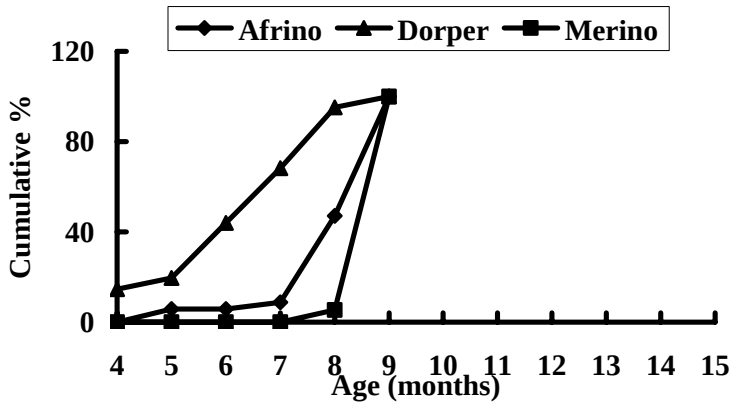

Figure 2 Cumulative percentage March-born Afrino, Dorper and Merino lambs slaughtered at both Grootvlei and Twistkraal

The gross income, using productive and reproductive data as reported above, is summarised in Table 7 for the three breeds at the two localities, using the current wool and meat prices. Animals of all breeds had a higher income per hectare and per ewe at Twistkraal than at Grootvlei. The higher reproductive rate, higher wool production and lower body weight of ewes at Twistkraal contributed to this outcome. From Table 7 it is clear that, with the current wool and mutton prices, Afrino sheep had the highest gross income per ewe, followed by Merino and Dorper ewes respectively. However, Merino sheep had the highest gross income per hectare at both localities. Afrino sheep performed intermediate, while Dorper sheep had the lowest gross income per hectare. The combination of low ewe body weights, high wool production and a relatively high reproductive rate, resulted in Merino sheep generating the highest income per hectare, compared to Afrino and Dorper sheep. Cloete *et al*. (2004b) reported a similar situation when comparing income of five Merino and Merino-type dam lines.

Table 7 Gross income for Afrino, Dorper and Merino sheep at Grootvlei and Twistkraal (Wool price = R 31.00/kg; Meat price = R 18.00/kg)

	Grootvlei			Twistkraal		
	Afrino	Dorper	Merino	Afrino	Dorper	Merino
Total income (R/ ewe)	R 553.47	R 382.05	R 460.94	R 654.07	R 441.97	R 480.53
Wool income (R/ ewe)	R 66.81		R 132.22	R 77.06		R 144.19
Meat income (R/ ewe)	R 486.66	R 382.05	R 328.72	R 577.01	R 441.97	R 336.34
Total income (R/ ha)	R 83.70	R 69.34	R 104.56	R 93.71	R 77.62	R 113.75
Total income (R/ LSU)	R 1 506.67	R 1 248.03	R 1 882.17	R 1 686.82	R 1 397.19	R 2 047.48

LSU - large stock unit

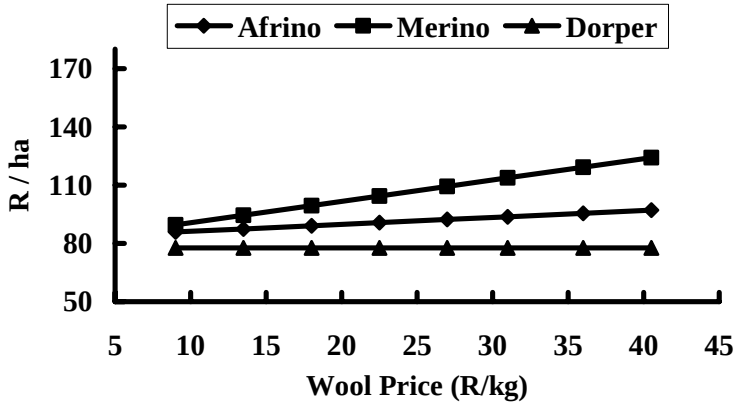

Figure 3 Gross income for the different breeds at a constant meat price (R 18.00/kg) and variable wool prices

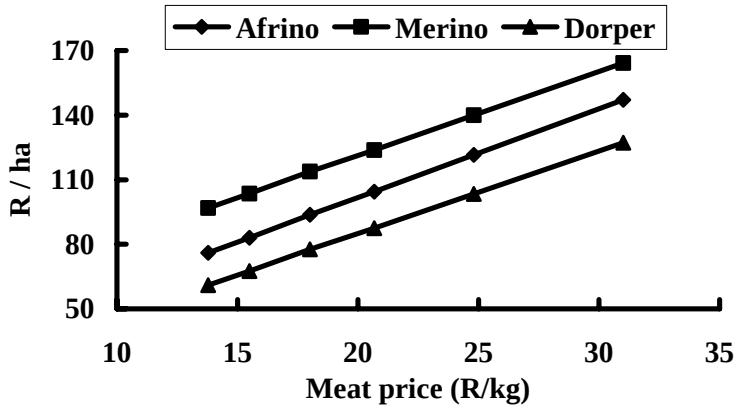

Figure 4 Gross income for the different breeds at a constant wool price (R 31.00/kg) and variable meat prices

The relative income from breeds could be influenced by the relative product prices of wool and meat. The gross income per hectare of the three breeds is illustrated in Figures 3 and 4 for various wool and meat price scenarios, using the productive and reproductive data recorded at Twistkraal.

Even over the wide range of wool : meat price ratios used, Merino sheep outperformed the other two breeds economically. This could be ascribed to the relatively high reproductive rate of the Merino ewes in this study, compared to the lower national average for Merino sheep (De Klerk *et al*., 1983), combined with their relatively low body weight. At lower reproductive rates and higher body weights, the other breeds could possibly outperform Merino sheep at the lower wool : meat price ratios.

Conclusions

It was evident from the results of this study, that when a specific Merino flock has a relatively high reproductive rate, they will outperform the other breeds at all wool : meat prices ratios. Furthermore, differences in productive and reproductive efficiency of Afrino, Merino and Dorper sheep occurred between the two localities studied. Reproductive rate, mature body weight and fibre production are the primary factors determining profitability of a specific sheep enterprise. These parameters should thus be considered when changing from one breed or commodity to another.

Acknowledgements

The authors wish to convey their sincere appreciation to the farm owner for permission to carry out the work, as well as for his financial contribution. The farm managers and farm aids of Grootvlei and Twistkraal and the responsible technicians and farm aids of GADI are also thanked for their assistance in the technical execution of the project.

References

Acocks, J.P.H., 1988. Veld types of South Africa. Memoirs of the Botanical survey of South Africa, 57, 1-146. Pretoria: Government Printers.

Badenhorst, M.A., Olivier, J.J., Cloete, J.A.N. & King, B.R., 1992. Produksie- en reproduksienorme vir Dorperskape in twee verskillende omgewings. Karoo Agric 4 (4), 9-11.

Botha, P., Blom, C.D., Sykes, E. & Barnhoorn, A.S.J., 1983. Comparison between the diets of small and large stock on mixed Karoo veld. Proc. Grass. Soc. Sthn. Afr. 18, 101-105.

Cloete, J.J.E., Hoffman, L.C., Cloete, S.W.P. & Fourie, J.E., 2004a. A Comparison between the body composition, carcass characteristics and retail cuts of South African Mutton Merino and Dormer sheep. S. Afr. J. Anim. Sci. 34, 44-51.

Cloete, S.W.P., Cloete, J.J.E., Herselman, M.J. & Hoffman, L.C., 2004b. Relative performance and efficiency of five Merino and Merino-type dam lines in a terminal crossbreeding system with Dormer or Suffolk sires. S. Afr. J. Anim. Sci. 34, 135-143.

Cloete, S.W.P., Snyman, M.A. & Herselman, M.J., 2000. Productive performance of Dorper sheep. Small Rumin. Res. 36, 119-135.

Department Of Agricultural Economics And Marketing, 1985. Act on the Conservation of Agricultural Resources (Act 43 of 1983). Government Gazette Nr R 2687, 6 December, 1985.

De Klerk, C.H., Düvel, G.H. & Terblanche, E. le F., 1983. 'n Ondersoek na wolskaapboerdery in die Republiek van Suid-Afrika. South African Institute for Extension Services, University of Pretoria.

Du Toit, P.C.V., 1998. Diets selected by Merino and Dorper sheep in Karoo veld. Grootfontein Agric 2 (1), 15-22.

Du Toit, P.C.V., 2000. Wat vreet verskillende skaaprasse in die Dorre Karoo? Grootfontein Agric 2 (2), 12-13.

Du Toit, P.C.V., Blom, C.D. & Immelman, W.F., 1994. Diet selection by different small stock species in the arid karoo. Karoo Agric 6 (1), 25-27.

Fourie, A.J. & Cloete, S.W.P., 1993. Reproductive performance of commercial Merino, Dohne Merino and SA Mutton Merino flocks in the Southern Cape. S. Afr. J. Anim. Sci. 23, 104-110.

Herselman, M.J., 2000. Die toepaslikheid van huidige grootvee-eenheidekwivalente van weidende skape.

Grootfontein Agric 2 (2), 6-8.
Herselman, M.J., 2002a. The role of simulation models in agricultural extension. Proc. 39th SASAS Congress, Christiana Aventura, 13-17 May, 189.
Herselman, M.J., 2002b. SM2000-programme: A simulation model for the calculation of profitability of different small stock enterprises. Available under "Downloads" at: http://gadi.agric.za
Littell, R.C., Freud, R.J. & Spector, P.C., 1991. SAS-system for linear models, (3rd ed.), Cary, N.C., USA.
Olivier, W.J., Olivier, J.J., Snyman, M.A., Pretorius, A.P. & Van Heerden, M., 2002. Production and reproduction norms of fine woolled Merino sheep on natural pastures in the Karoo. Grootfontein Agric 5, 29-31.
SAS, 1996. SAS Procedures Guide, (Version 6, 3rd ed.), SAS Institute. Inc., Cary, N.C., USA.
Schoeman, S.J., De Wet, R., Botha, M.A. & Van der Merwe, C.A., 1995. Comparative assessment of biological efficiency of crossbred lambs from two composite lines and Dorper sheep. Small Rumin. Res. 16, 61-67.
Snyman, M.A., Erasmus, G.J., Van Wyk, J.B. & Olivier, J.J., 1995. Direct and maternal (co)variance components and heritability estimates for body weight at different ages and fleece traits in Afrino sheep. Livest. Prod. Sci. 44, 229-236.
Snyman, M.A., Herselman, M.J., Cloete, J.A.N. & King, B.R., 2000. Bruto marge van Afrino, Dorper en Merinoskape. Grootfontein Agric 2 (2), 9-11.
Snyman, M.A. & Olivier, W.J., 2002. Productive performance of hair and wool type Dorper sheep under extensive conditions. Small Rumin. Res. 45, 17-23.
Snyman, M.A., Olivier, J.J., Cloete, J.A.N. & King, B.R., 1993. Produksienorme vir Afrinoskape in twee omgewings. Karoo Agric 5 (1), 25-28.