COMPARISON OF RED MAASAI AND DORPER SHEEP FOR RESISTANCE TO GASTRO-INTESTINAL NEMATODE PARASITES, PRODUCTIVITY AND EFFICIENCY IN A HUMID AND A SEMI-ARID ENVIRONMENT IN KENYA

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INTRODUCTION

In a study conducted in the humid environment of the Kenya coast Red Maasai sheep were shown not only to be more resistant to gastrointestinal (GI) nematode parasites (particularly *Haemonchus contortus*) but also 3 fold more productive than Dorper sheep (Baker, 1998 ; Baker *et al*., 1999). This result was mainly due to the very low reproductive rate and high mortality rate in Dorper sheep in this humid environment. Since the Dorper breed was originally bred for use in the arid extensive regions of South Africa (Cloete *et al*., 2000) it is perhaps not surprising that it is very poorly adapted to humid conditions. In this paper we compare the disease resistance / tolerance, productivity and efficiency of Red Maasai and Dorper sheep evaluated in experiments at the Kenya coast (humid environment) and the Kenya highlands (semi-arid environment).

MATERIALS AND METHODS

Experimental sites. The first study was undertaken at Diani Estate of Baobab Farm Ltd., in the humid coastal region of Kenya (Baker, 1998 ; Baker *et al*., 1999). Red Maasai (R), Dorper (D) and their crosses were evaluated at this site between 1991 and 1996. The backcrosses were generated by mating purebred R (35) and D (41) rams to F_1 (RxD) ewes. The second study was initiated in 1997 at Kapiti Plains in the semi-arid highland region of Kenya to generate double-backcross resource families. The Kapiti families were used to search for quantitative trait loci (QTL) and ultimately genes for resistance and tolerance to GI nematode parasites (Okomo *et al*., 2000). Six F_1 (Red Maasai/Dorper) rams were mated to both Red Maasai and Dorper ewes. Matings continued at 6-monthly intervals until by December 2000 six lamb crops had been produced and about 200 backcross lambs per family. In addition, in each lamb crop small numbers (20-30) of purebred Red Maasai and purebred Dorper lambs were also produced and over the 6 lamb crops 15 Red Maasai and 16 Dorper rams were used.

Experimental protocol. The predominant GI parasites at both experimental sites were *H. contortus* and *Trichostrongylus spp.* The experimental protocol to assess resistance to GI parasites at Diani Estate was described in detail by Baker (1998) and Baker *et al*., (1999). Briefly, all lambs were weighed at birth and had live weight (LWT), faecal egg count (FEC) and blood packed cell volume (PCV) recorded at 1, 2, and 3 months of age, then treated with an anthelmintic and weaned. They were then grazed on pasture until a monitor group of about 40-50 lambs, which were sampled every week, reached an average FEC of about 1500-2000 eggs per gram (epg). When this threshold mean FEC was reached all animals in the grazing group were weighed and FEC and PCV recorded on two consecutive days. Then all lambs were drenched and the procedure repeated until they reached about a year of age. The experimental protocol for lambs at Kapiti was identical from birth to weaning. After weaning the lambs were subjected to just one pasture challenge (lambs 4 to 6 mo of age) and then an indoor trickle challenge for about 5-7 weeks with *H. contortus*. The ewes at both sites had LWT, PCV and FEC recorded six times during the reproductive cycle : at mating, 3 months after mating, 2 weeks before lambing and 1, 2 and 3 months after lambing.

Statistical analysis. The breed effects reported in this paper for lambs were derived from least squares analysis of variance of single-born lambs fitting, when significant ($P < 0.05$), main effects for year of birth (Diani data), lamb crop (Kapiti data), breed/crossbreed, sex, age of dam, age of lamb (birth date for analysis of birth weight) as a linear covariate and any significant interactions. Breed effects for ewes were derived from analyses of variance fitting breed, year of birth or lamb crop, ewe age and any significant interactions. Faecal egg counts were logarithm transformed ($\log_{10}$ (FEC+25)) to normalise the variance.

RESULTS AND DISCUSSION

Breed effects : Ewes (table 1). At the coast the Red Maasai had a significantly higher overall reproductive rate (LW/EM) than Dorpers while in the highlands there was no significant breed difference because Dorpers had much better reproductive performance than on the coast.

Table 1. Least squares means for ewes of the Red Maasai (RM) and Dorper breeds for live weight (LWT, kg), packed cell volume (PCV, %), the anti-log of logarithm faecal egg count (ALFEC, eggs per gram) and reproduction at the two experimental sites

Traits	Kenya - humid[A] (1991 – 1996)		Kenya – semi-arid[A] (1998 – 2000)	
	RM	Dorper	RM	Dorper
No. ewes mated (EM)	442	807	1015	1055
LWT-mating	27.7[a]	30.6[b]	30.2[a]	46.1[b]
PCV-mating	26.1[a]	24.6[b]	33.3[a]	31.4[b]
ALFEC-mating	378[a]	525[b]	204[a]	178[a]
PCV – lactating ewes	24.0[a]	22.2[b]	28.3[a]	26.0[b]
ALFEC – lactating ewes	692[a]	988[b]	2187[a]	3090[b]
EL/EM[B]	0.80[a]	0.65[b]	0.78[a]	0.73[b]
LB/EL[B]	1.02[a]	1.02[a]	1.01[a]	1.16[b]
LW/LB[B]	0.93[a]	0.73[b]	0.95[a]	0.89[b]
LW/EM[B]	0.71[a]	0.48[b]	0.73[a]	0.70[a]
Annual mortality	0.05[a]	0.27[b]	0.068[a]	0.081[a]

[A] Means with different superscripts are significantly different ($P < 0.05$).
[B] EL = ewes lambing ; LB = lambs born ; LW = lambs weaned

While the Dorper ewes were significantly heavier than Red Maasai ewes at both sites they showed their growth superiority much more clearly in the semi-arid conditions at Kapiti. Red

Maasai ewes were significantly more resistant to GI nematodes than Dorpers at both sites as shown by their higher PCV and lower ALFEC (except at mating at Kapiti) both in dry ewes (at mating) and in lactating ewes.

Breed effects : Lambs (table 2). Red Maasai lambs had a significantly higher PCV than Dorper lambs at 3 and 6 months of age at both sites. Consistent breed differences for ALFEC were also found for 6-month-old lambs at both sites (Red Maasai having lower egg counts), but in 3-month-old lambs there was a significant breed effect for ALFEC at Kapiti but not at the coast. Consistent with ewe performance, the LWT for lambs was higher at Kapiti than at the coast resulting in the Dorper lambs being about 50 % heavier than the Red Maasai lambs at Kapiti but only 5 – 10 % heavier at the coast. Conversely, the Dorper lambs had a much higher mortality rate than Red Maasai lambs at the coast than at Kapiti. In general the ¾ RM and ¾ D lambs showed additive breed effects for LWT, PCV, ALFEC and mortality rates.

Table 2. Least squares means for single-born lambs by breed and crossbreed for live weight (LWT, kg), packed cell volume (PCV, %) the anti-log of logarithm faecal egg count (ALFEC, epg) and mortality (%)

Traits	Kenya - humid^{A}				Kenya – semi-arid^{A}			
	RM	¾ RM	¾ D	D	RM	¾ RM	¾ D	D
No. born	216	470	427	318	156	667	503	99
- LWT	2.3^{a}	2.3^{a}	2.5^{b}	2.5^{b}	2.9^{a}	3.2^{a}	3.9^{b}	4.1^{b}
No. wnd-3mo	182	394	332	226	152	636	467	95
- LWT	10.1^{a}	10.7^{b}	10.9^{b}	11.0^{bc}	13.0^{a}	14.9^{b}	18.5^{c}	20.2^{d}
- PCV	27.8^{a}	27.1^{a}	25.7^{b}	24.2^{b}	35.1^{a}	35.8^{a}	35.0^{a}	33.3^{b}
- ALFEC	676^{a}	646^{a}	955^{a}	832^{a}	741^{a}	927^{a}	1380^{b}	1698^{b}
LWT- 6mo	13.0^{a}	13.7^{ab}	14.3^{b}	14.2^{b}	15.2^{a}	17.1^{b}	22.5^{c}	24.5^{d}
PCV- 6mo	24.6^{a}	24.1^{a}	21.9^{b}	21.9^{b}	26.1^{a}	26.0^{a}	24.1^{b}	21.0^{c}
ALFEC- 6mo	1950^{a}	2089^{a}	2291^{ab}	2818^{b}	$8,128^{a}$	6918^{a}	9057^{ab}	14125^{c}
LWT–12mo^{B}	17.5^{a}	18.2^{b}	18.4^{b}	18.4^{b}	20.0	22.0	27.0	30.0
Mortality								
Bth – 3mo	9.9^{a}	13.7^{a}	19.2^{b}	28.3^{b}	3.1^{a}	4.9^{a}	7.0^{a}	5.4^{a}
3 – 12 mo	15.9^{a}	13.0^{a}	35.7^{b}	44.7^{b}	2.0^{a}	3.1^{a}	7.3^{b}	10.0^{b}

^{A} RM = Red Maasai, D = Dorper. Means with different superscripts are significantly different ($P < 0.05$). ^{B} LWT at 12 mo at Kapiti (semi-arid) interpolated from 9 mo LWT.

Breed effects : Flock productivity and efficiency (table 3). Flock productivity was derived from the parameters in tables 1 and 2 as the number or weight of yearling sheep for sale based on a 100-ewe flock with a 20 % female replacement rate with all the male progeny and non-replacement females alive at one year of age making up the potential offtake. At the coast the Red Maasai sheep were about 3-fold more productive than Dorper sheep in terms of either number of sheep for sale or weight of sheep for sale (Baker *et al.*, 1999). The Dorpers were non-sustainable at the coast at a 20 % replacement rate so the 3-fold difference in offtake is an under-estimate. However, in the highlands there was a much smaller advantage for the Red Maasai over the Dorper in terms of number of sheep for sale (20 %), while in terms of weight of sheep for sale the Dorpers were more productive than the Red Maasai by 25 %. Efficiency was estimated as kg total offtake (as above) per Carrying Capacity Unit (CCU) per year using the livestock production efficiency approach (James and Carles, 1996). The Red Maasai were about 5 fold more efficient than the Dorpers at the coast and the negative efficiency value for the Dorpers indicates they were not sustainable in this humid environment. In contrast, there was no significant difference between the breeds for efficiency in the semi-arid environment.

Table 3. Flock productivity and efficiency of the Red Maasai (RM) and Dorper breeds

Traits	Kenya - humid (1991 – 1996)		Kenya – semi-arid (1998 – 2000)	
	RM	Dorper	RM	Dorper
Productivity - offtake				
No. sheep for sale	40	13	48	40
Weight of sheep (kg)	700	239	960	1200
Efficiency				
Kg/CCU[A]/year	153.9	-36.5	164.8	167.5
Ratio	5.2	1.0	5.5	5.6

[A] One CCU = 100 megajoules of metabolisable energy per day

CONCLUSION

Important shortcomings of much of the published literature on breed comparisons for resistance to GI nematodes in sheep and goats are that the experimental design was inadequate (small numbers of animals per breed, inadequate sampling, etc.) and there was no attempt to relate parasitological parameters for resistance to breed productivity or efficiency (Baker, 1998). Both these issues have been addressed in the studies presented here. There were important breed by location interactions for LWT, mortality rates and reproduction rates. When all these parameters were combined it was found that the indigenous Red Maasai sheep were 3- to 5-fold more productive and efficient than Dorper sheep in the humid coastal environment. In the semi-arid environment Dorper sheep were slightly more productive than the Red Maasai, but there was no significant difference in flock efficiency between the breeds.

REFERENCES

Baker, R.L. (1998) *Anim. Genet. Resources Information. Bull.* **24** : 13-30.
Baker, R.L., Mwamachi, D.M., Audho, J.O., *et al.*. (1999). *Anim. Sci.* **69** : 335-344.
Cloete, S.W.P., Snyman, M.A. and Herselman, M.J. (2000). *Small Rumin. Res.* **36** : 119-135.
James, A.D. and Carles, A.B. (1996) *Agric. Systems* **52** : 271-291.
Okomo, M.A., Mugambi, J.M., Aduda, E.O., *et al.* (2000). *Proc.27th International Conference on Animal Genetics, Abstract Book*, p. 25.