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# Comparison of Landim and Africander Cattle in Southern Mozambique: I. Body Weights and Growth

J.G.V. Carvalheira<sup>†</sup>, R. W. Blake\*, E. J. Pollak\*, and P. J. Van Soest\*

\*Cornell University, Ithaca, NY 14853 and <sup>†</sup>Eduardo Mondlane University, Maputo, Mozambique

**ABSTRACT:** The growth performance of Landim and Africander breeds was compared using data collected from 1968 to 1981 at the Chobela Research Station in Mozambique. Animals from both breeds were managed together in groups by age and sex, except when separated for breeding. Growth traits were body weights at birth, weaning at 7 mo, 18 mo, and first calving, and pre- and postweaning daily growth rates. These traits were analyzed using a mixed-effects least squares model containing breed, year-season of birth, sex, the nested effect of parity within breed, a linear regression on dam's age, and the

random effect of sire within breed. Africander calves were 16, 9, and 7% heavier ( $P < .01$ ) than Landim calves at birth, weaning, and 18 mo ( $18 \pm 6$  kg heavier than the 237-kg Landim average). However, there was no detectable difference for age-adjusted weight at first calving and postweaning daily growth rate. Diminishing weight and growth differences with advancing age may indicate adaptation by the Landim to the prevailing environmental limitations in southern Mozambique, especially through younger ages at puberty and at first calving.

Key Words: Beef Cattle, Landim, Africander, Body Weight, Africa

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## Introduction

Mozambique and the other countries in southeastern Africa have particularly stressful environments for cattle production due to harsh climate and high incidence of disease (Scholtz, 1988). Managing breeding programs requires accurate assessments of the socioeconomic and biophysical parameters of the environment, and the germplasms that may be useful in this context. Indigenous livestock represent the logical choice on which to predicate such programs. These populations constitute the gene pool for adaptability that is fit enough to survive in African environments. A necessary step for objectively deciding which breeds to include (or not) in genetic management programs is to quantify the differences between them.

Approximately 70% of cattle in southern Mozambique are Landim (also known as Nguni), an indigenous breed that is managed with very little feed input besides grazing natural vegetation. The second most numerous breed in this region is the Africander, which was imported from South Africa around 1920 (Silva, 1966).

The objectives of this study were to compare body weights and average growth rates of Landim and Africander breeds in the Chobela Research Station herd. Chobela has environmental conditions like those prevailing in southern Mozambique (e.g., semi-arid with a unimodal rainfall pattern).

## Materials and Methods

Data for this study were collected at the Chobela Research Station, Magude, Mozambique (32°14' E latitude and 25°00' S longitude). This 3,200-ha station, established in 1917, is situated 40 m above sea level on flat topography. Landim cattle were brought there in 1940, and Africander cattle were introduced in 1944. Both breeds belong to the Sanga group, a term generalized by Mason and Maule (1960) to refer to all eastern and southern Africa cattle with small cervico-thoracic humps. Subsequently, these breeds were managed together with their objective comparison as a primary goal. The general culling criteria were based on fertility, growth, and conformation.

A detailed description of the physical environment was given by Carvalheira (1992). The climate is typical for a dry tropical region with an average annual rainfall of  $686 \pm 156$  mm, average temperature of 23.3°C, and 72% average relative humidity (for the

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period 1952 to 1968). The unimodal rainfall pattern results in two main seasons: a rainy, hot season and a dry, relatively cool one. The rainy season usually starts in October or November and extends to March or April. The months with the greatest and the least average precipitation, respectively, were February and August for the 28-yr period from 1952 to 1980. For the same period, the highest average maximum temperature was 32.5°C in January and the lowest mean maximum temperature was 18.7°C in July. The average monthly minimum temperature was never less than 10°C.

Natural pastures in this region mainly comprise *Themeda trianda* (red grass) and *Panicum maximum* (guinea grass) (Silva, 1966). The major management challenge is determining the correct or optimal stocking rate(s) that control brush encroachment on pasture lands, especially *Acacia* species.

**Herd Management.** Landim and Africander breeds were managed together and grouped by age and sex (e.g., weanlings [both sexes], heifers, older females of breeding age with or without suckling calves, and young and mature bulls). During the breeding season (February to April), groups of 25 breeding females were separated by breed and serviced by one bull of the same breed, which permitted accurate identification of service sires. Service sires were routinely clinically examined prior to each mating season.

The calving period was managed to coincide with the beginning of the rainy season in October and November. More than 40% of calvings occurred in December, which was the mode of a near-symmetric, bell-shaped frequency distribution of calvings by month. Unselected males were castrated at 18 mo of age to facilitate breeding management, and later sold at 3 to 4 yr of age weighing approximately 400 kg. Females not pregnant after two consecutive breeding seasons, which occurred in contiguous years, were slaughtered.

Calves were weaned at approximately 7 mo of age in August and September. Herd replacements were selected based on body weight at approximately 18 mo of age to maintain herd size approximately constant. All animal groups were grazed on natural pastures at a rate of 3 to 4 ha per animal unit (1 AU = 450 kg live weight). Supplementation, which consisted of rice straw, molasses, and urea, was given only in the dry seasons of the driest years. Preventive health measures included vaccinations against anthrax, blackleg, salmonellosis, and brucellosis. All animals were screened and culled annually for tuberculosis. External parasites, especially ticks, were controlled by weekly dipping throughout the year.

**Data.** The data consisted of body weights and dates of birth and calving of Landim and Africander cattle from 1968 to 1981. The few records before 1975 were pooled with the ones from 1975.

Body weights were recorded at birth, weaning at approximately 7 mo, 18 mo, and first calving. Weights at weaning and 18 mo were adjusted to 210 and 540 d

of age by linear interpolation between the values obtained from multiple weighings preceding and subsequent to these ages (1 mo between measurements). Besides body weights, pre- and postweaning average daily gains were calculated from birth to weaning and from weaning to 18 mo, respectively.

Dates of calving (birth) were classified in two seasons, either early (July 1 through December 31) or late (January 1 to June 30) in the rainy season. Approximately two-thirds of calvings occurred early in the rainy season. Preliminary analysis showed that these seasons importantly affected most traits.

A subset of these data (records from 1975 to 1980, approximately 90%) was used by Dionisio and Syrstad (1990) to evaluate these breeds for weights at weaning and 18 mo, average daily growth in this period, and average calving interval. The data in their study were analyzed separately by breed and mean differences were tested by Student's *t*-test.

**Statistical Analyses.** Least squares methods were implemented using the GLM procedure of SAS (1985). A mixed-effects model was used to evaluate the breed differences. The statistical model for the growth traits (weights at birth, weaning, and 18 mo, and average daily growth for pre- and postweaning periods) was as follows:

$$Y_{ijklmn} = \mu + B_i + YS_j + G_k + P_l(B_i) + b_i\{AGE_{ijklmn}(B_i)\} + S_m(B_i) + \epsilon_{ijklmn}$$

where

$Y_{ijklmn}$  = the record of the  $n^{\text{th}}$  calf of the  $i^{\text{th}}$  breed, the  $k^{\text{th}}$  sex, and born in the  $j^{\text{th}}$  year-season to the  $m^{\text{th}}$  sire and a dam in the  $l^{\text{th}}$  parity class,

$\mu$  = the overall mean,

$B_i$  = the  $i^{\text{th}}$  breed (Landim or Africander),

$YS_j$  = the  $j^{\text{th}}$  year-season of birth,

$G_k$  = the  $k^{\text{th}}$  sex,

$P_l$  = the  $l^{\text{th}}$  parity class within breed, accounting for differences in physiological status, where  $l = 1$  for primiparous heifers,  $l = 2$  for cows calving in the preceding year or  $l = 3$  for cows not calving in the preceding year,

$b_i$  = the linear regression coefficient for the respective growth trait on age of dam for the  $i^{\text{th}}$  breed,

$AGE_{ijklmn}$  = the residual age of dam effect (mo) for the  $n^{\text{th}}$  individual nested within breed that was unaccounted by parity class,

$S_m$  = the random effect of the  $m^{\text{th}}$  sire nested within breed, which yielded the expected mean square for sire/breed to test the effect of breed (EMS =  $k_1[MS(\text{sire/breed})] + k_2[MS(\text{residual})]$ , where  $k_1 + k_2 = 1.0$ , and with df approximated by Satterthwaite's formula; Littell et al., 1991), and

Table 1. Least squares means ( $\bar{x}$ ) and standard errors (SE) for breed, sex, and parity effects on body weights (kg) at birth, weaning, and 18 months of age of Landim and Africander breeds

Effect	Birth			Weaning			18 mo		
	n	$\bar{x} \pm \text{SE}$	$\Delta\%^a$	n	$\bar{x} \pm \text{SE}$	$\Delta\%^a$	n	$\bar{x} \pm \text{SE}$	$\Delta\%^a$
<b>Breed</b>									
La <sup>b</sup>	402	32.6 ± .6	2.45	332	149.5 ± 2.4	-.67	224	237.1 ± 3.9	.21
Af <sup>b</sup>	374	37.7 ± .6	1.59	319	163.4 ± 2.9	.92	225	254.6 ± 3.8	-.94
<b>Sex</b>									
F	380	34.5 ± .5	2.03	340	152.6 ± 2.0	.20	240	231.6 ± 2.9	-.43
M	396	35.9 ± .5	1.95	311	161.1 ± 2.0	.00	209	261.0 ± 3.1	-.34
<b>Parity<sup>c</sup></b>									
<b>La</b>									
Heifer	94	33.0 ± .9	.91	80	149.7 ± 3.5	-.47	52	238.0 ± 6.0	1.85
Cow 1	235	32.8 ± .7	3.96	192	151.0 ± 2.6	-1.59	123	237.2 ± 4.4	-1.81
Cow 2	73	32.3 ± .9	.61	60	149.0 ± 3.6	.07	49	237.3 ± 5.8	.84
<b>Af</b>									
Heifer	95	36.2 ± .8	2.47	73	160.2 ± 3.9	1.12	50	253.8 ± 5.5	-.39
Cow 1	166	37.7 ± .7	1.86	154	163.4 ± 3.3	.67	101	254.6 ± 4.9	-1.34
Cow 2	113	39.2 ± .7	.51	92	167.7 ± 3.3	.66	74	256.5 ± 4.8	-1.05

<sup>a</sup>Percentage of difference between least squares means from the fixed-effects model (f) and the mixed model (m):  $[(\bar{x}_f - \bar{x}_m) \div \bar{x}_m] \times 100$ .

<sup>b</sup>La = Landim; Af = Africander.

<sup>c</sup>Cow 1 = cow that calved in the previous year; Cow 2 = cow that did not calve in the previous year.

$\epsilon_{ijklm}$  = the vector of residuals, which was assumed  $N(0, I\sigma^2)$ .

The statistical model for weight at first calving was as follows:

$$y_{ijklm} = \mu + B_i + YSC_j + b_i\{AFC_{ijklm}(B_i)\} + S_k(B_i) + \epsilon_{ijklm}$$

where

$y_{ijklm}$  = the record of the  $m^{\text{th}}$  female of the  $i^{\text{th}}$  breed, born to the  $k^{\text{th}}$  sire, and that calved in the  $j^{\text{th}}$  year-season,

$\mu$  = the overall mean,

$B_i$  = the  $i^{\text{th}}$  breed (Landim or Africander),

$YSC_j$  = the  $j^{\text{th}}$  year-season of calving,

$b_i$  = the linear regression coefficient of weight at first calving on age at first calving for the  $i^{\text{th}}$  breed,

$AFC_{ijklm}$  = the age of the  $m^{\text{th}}$  female at first calving (mo) nested within breed,

$S_k$  = the random effect of the  $k^{\text{th}}$  sire nested within breed, which yielded the expected mean square for sire/breed to test the effect of breed with df approximated by Satterthwaite's formula (Littell et al., 1991), and

$\epsilon_{ijklm}$  = the vector of residuals, which was assumed  $N(0, I\sigma^2)$ .

Estimable linear contrasts of least squares means from these models were computed to evaluate breed differences and other main effects for each trait.

The data were originally analyzed using a fixed-effects model to avoid discarding information from

10% of the records that were not sire-identified. Sires of both breeds were similarly represented across years and seasons, and 91 to 99% of the expected mean squares for the effect of sire/breed were from within-family (residual) variation. Both models (with and without the sire effect) were applied to the data to document the accuracy of partitioning the sums of squares and to assuage potential concern about the corresponding conclusions. As should be expected, only minor differences resulted between the mixed and the fixed-effects models, which are reported as percentages in the tables. Identical conclusions were obtained.

## Results and Discussion

Least squares means by breed, sex, and parity and their standard errors are presented in Table 1 for body weights at birth, weaning, and 18 mo and in Table 2 for daily growth rates from birth to weaning and from weaning to 18 mo. Mean squares and tests of significance for the main effects are shown in Tables 3, 4, and 5. Linear contrasts, least squares means, and their standard errors for the weight and growth traits are given in Tables 1, 2, 5, and 6.

**Birth Weight.** Breed, sex, year-season of birth, parity, and sire affected ( $P < .05$ ) birth weights (Table 3). Age of dam (Landim averaged 71.5 mo, Africander averaged 77.1 mo), included as a covariable within breed, was important in reducing the error variance ( $P < .01$ ).

Calves born in the early rainy season (July through December) averaged  $1.0 \pm .7$  kg lighter than those born late in the rainy season (January through June). Cows calving early in the rainy season are in relatively poor body condition (i.e., low tissue

Table 2. Least squares means ( $\bar{x}$ ) and standard errors (SE) for breed, sex, and parity effects on daily growth rates (kg/d) from birth to weaning and from weaning to 18 months of Landim and Africander breeds

Effect	Birth-to-weaning			Weaning-to-18 mo		
	n	$\bar{x} \pm \text{SE}$	$\Delta\%$ <sup>a</sup>	n	$\bar{x} \pm \text{SE}$	$\Delta\%$ <sup>a</sup>
Breed						
La <sup>b</sup>	297	.557 $\pm$ .011	-.36	220	.267 $\pm$ .011	1.87
Af <sup>b</sup>	289	.599 $\pm$ .013	.50	218	.276 $\pm$ .010	-5.43
Sex						
F	298	.561 $\pm$ .009	.00	237	.245 $\pm$ .008	-2.04
M	288	.598 $\pm$ .009	-.33	201	.298 $\pm$ .009	-1.34
Parity <sup>c</sup>						
La						
Heifer	71	.552 $\pm$ .017	-.18	50	.274 $\pm$ .017	4.74
Cow 1	168	.562 $\pm$ .012	-2.49	122	.260 $\pm$ .012	-.77
Cow 2	58	.562 $\pm$ .017	1.07	48	.268 $\pm$ .016	1.87
Af						
Heifer	65	.595 $\pm$ .018	.17	48	.282 $\pm$ .016	-4.26
Cow 1	133	.596 $\pm$ .016	.17	100	.271 $\pm$ .013	-6.27
Cow 2	91	.611 $\pm$ .015	.33	70	.275 $\pm$ .013	-6.18

<sup>a</sup>Percentage of difference between least squares means from the fixed-effects model (f) and the mixed model (m):  $[(\bar{x}_f - \bar{x}_m) \div \bar{x}_m] \times 100$ .

<sup>b</sup>La = Landim; Af = Africander.

<sup>c</sup>Cow 1 = cow that calved in the previous year; Cow 2 = cow that did not calve in the previous year.

reserves) following a nutritionally stressful dry season. As a consequence, lighter calves are born from these cows. The nutritional environment improves dramatically with the start of the rainy season (October to November). Therefore, cows calving after December are in better body condition, which is reflected in the greater weights of their calves at birth, and which agrees with findings in Botswana (Buck et al., 1976). Sex differences were like those in other reports (Trail et al., 1977; Scholtz, 1988; Tawonezvi et al., 1988). Male calves averaged approximately 4% heavier ( $P < .01$ ) than female calves, which averaged approximately 35 kg. Birth weights were less for

calves from primiparous than for calves from pluriparous females (Table 6).

Africander calves were 14% heavier at birth ( $P < .01$ ) than Landim calves (Tables 1 and 6). These results agree with previous reports indicating that Africander is one of the breeds with heaviest birth weights in the region (Trail et al., 1977; Scholtz, 1988; Tawonezvi et al., 1988). Birth weight has economic merit only indirectly through associations with survival rate and the obvious need for less gain by heavier animals to reach market or breeding weight. Roberson et al. (1986) indicated that large cows usually produce large calves, which has been at-

Table 3. Mean squares (MS) and degrees of freedom (df) for body weights (kg) at birth, weaning, and 18 months for Landim and Africander breeds

Source	Birth			Weaning			18 mo		
	df <sup>a</sup>	MS <sup>a</sup>	MS <sup>b</sup>	df <sup>a</sup>	MS <sup>a</sup>	MS <sup>b</sup>	df <sup>a</sup>	MS <sup>a</sup>	MS <sup>b</sup>
Breed (B)	1	849.1**	1,023.5**	1	6,154.2**	11,930.0**	1	7,300.5**	9,295.8**
Sire/B	44	36.3**	—	37	548.9*	—	29	710.4	—
Age of dam/B	2	128.6**	81.8*	2	1,060.9	1,421.7*	2	1,178.2	1,677.4
Year-season (YS)	10	186.9**	277.1**	9	2,570.8**	8,438.7**	7	5,835.5**	6,309.5**
Sex	1	326.8**	415.0**	1	10,793.5**	11,040.1**	1	86,142.4**	97,534.2**
Parity/B	4	73.2*	65.3*	4	405.6	382.7	4	42.1	687.9
YS $\times$ B	—	—	75.8**	—	—	948.8*	—	—	537.4
Residual	713	22.4	22.9	596	368.7	370.6	404	686.0	681.3
EMS <sup>c</sup>	719.6	23.4	—	614.7	381.1	—	432.9	687.6	—

<sup>a</sup>Mixed model.

<sup>b</sup>Fixed-effects model.

<sup>c</sup>Approximate df and expected mean squares (EMS) to test the breed effect (Littell et al., 1991).

\* $P < .05$ .

\*\* $P < .01$ .

Table 4. Mean squares (MS) and degrees of freedom (df) for daily growth rates (kg/d) from birth to weaning and from weaning to 18 months of Landim and Africander breeds

Source	Birth-to-weaning			Weaning-to-18 mo		
	df <sup>a</sup>	MS <sup>a</sup>	MS <sup>b</sup>	df <sup>a</sup>	MS <sup>a</sup>	MS <sup>b</sup>
Breed (B)	1	.029 <sup>†</sup>	.069**	1	.004	<.001
Sire/B	35	.010	—	28	.005	—
Age of dam/B	2	.003	.007	2	.001	.001
Year-season (YS)	8	.042**	.244**	7	.054**	.154**
Sex	1	.178**	.184**	1	.274**	.318**
Parity/B	4	.003	.007	4	.001	.007
YS × B	—	—	.014	—	—	.005
Residual	534	.008	.008	394	.005	.005
EMS <sup>c</sup>	558.5	.008	—	418.7	.005	—

<sup>a</sup>Mixed model.<sup>b</sup>Fixed effects model.<sup>c</sup>Approximate df and expected mean squares (EMS) to test the breed effect (Littell et al., 1991).<sup>†</sup> $P = .07$ .\*\* $P < .01$ .

tributed to a genetic maternal effect. Although calving difficulties are uncommon in tropical breeds (Galina and Arthur, 1989), Barlow (1984) acknowledged potential detriment from more dystocia by selecting for birth weight in adapted breeds.

*Weaning Weight.* Breed, sex, year-season of birth, and sire had detectable effects ( $P < .05$ , Table 3) on weaning weight. Average ages of dam at weaning ( $P = .06$ ) were 78 mo for Landim and 85 mo for Africander. Parity class did not influence weaning weight ( $P = .36$ ).

Weaning weight differed between years ( $P < .01$ ) but no temporal pattern was discernible. Differences

in annual rainfall, which directly influence pastures, may explain these fluctuations in average weaning weight (Carvalho, 1992). Males were 6% heavier ( $P < .01$ ) than females, averaging 153 kg (Tables 1 and 6).

Africander calves averaged  $14 \pm 4$  kg heavier than Landim calves, whose mean weaning weight was 150 kg ( $P < .01$ ). Most studies in the region (Scholtz, 1988; Tawonezvi et al., 1988; and Dionisio and Syrstad, 1990) found the Africander to be heavier at weaning than other local Sanga breeds (Tswana, Landim or Nguni, Tuli, Mashona, and Nkone), except for the findings by Trail et al. (1977) in Botswana.

Table 5. Mean squares (MS) and degrees of freedom (df), least squares means ( $\bar{x}$ ) and estimated linear contrasts of least squares means (Est) and SE on body weight at first calving (kg) for Landim and Africander breeds

Source	df <sup>a</sup>	MS <sup>a</sup>	MS <sup>b</sup>	n	$\bar{x}$ or Est	SE	$\Delta\%$ <sup>f</sup>
Breed (B)	1	1,886.6	457.5	—	—	—	—
Landim				55	378.2	19.3	2.30
Africander				61	369.8	14.6	-2.41
Landim minus Africander					8.4	28.6	
Sire/B	18	1,254.6	—				
Age/B <sup>c</sup>	2	6,038.8**	15,104.7**				
Year-season <sup>d</sup>	6	1,056.3	8,394.6**				
Calving season (early minus late)					.4	5.3	
Residual	88	888.5	1,118.6				
EMS <sup>e</sup>	90.4	892.1	—				

<sup>a</sup>Mixed model.<sup>b</sup>Fixed-effects model.<sup>c</sup>Age at first calving.<sup>d</sup>Year-season of calving.<sup>e</sup>Approximate df and expected mean squares (EMS) to test the breed effect (Littell et al., 1991).<sup>f</sup>Percentage difference between least squares means from the fixed-effects model (f) and the mixed model (m):  $[\bar{x}_f - \bar{x}_m] \div \bar{x}_m \times 100$ .\*\* $P < .01$ .

Table 6. Estimated linear contrasts of least squares means (Est) for weights (kg) at birth, weaning, 18 months, and daily growth rates (kg/d) from birth to weaning (B-to-W) and from weaning to 18 months (W-to-18) for Landim and Africander breeds

Contrast	Birth		Weaning		18 mo		B-to-W		W-to-18	
	Est	SE	Est	SE	Est	SE	Est	SE	Est	SE
Landim minus Africander	-5.1	.76**	-14.1	3.8**	-17.5	5.5**	-.043	.017*	-.009	.015
Birth season (early minus late)	-1.0	.65	7.6	2.1**	17.2	3.0**	.013	.007	.017	.004**
Female minus male	-1.4	.35**	-8.5	1.6**	-29.3	2.6**	-.036	.008**	-.053	.007**
Parity <sup>a</sup>										
Heifers minus cows	-.9	.56	-2.8	2.5	-.5	4.2	-.009	.013	.010	.012
Cow 1 minus cow 2	.5	.52	-1.1	2.4	-1.0	4.0	-.008	.012	-.006	.011

<sup>a</sup>Cow 1 = cow that calved in the previous year; Cow 2 = cow that did not calve in the previous year.

\* $P < .05$ .

\*\* $P < .01$ .

Season of birth affected weaning weight and birth weight ( $P < .01$ ) in an opposite manner. Calves born early were  $8 \pm 2$  kg heavier at weaning (Table 6) than those born late in the rainy season (i.e., after December). Correspondingly, Maule (1973) referred to studies in South Africa in which weaning weights of Africander calves decreased 2.9 kg per week for births occurring after October.

Cows calving late in the rainy season (January and later) encounter mature and less digestible pastures than dams of calves born earlier, which has certain detrimental influence on milk yield. Heavier birth weight probably facilitates survival of calves born after December that receive less nutritional support (milk) from dams grazing poorest pastures. Conversely, the lighter calves born early in the rainy season benefit most from a nutritional environment provided by dams whose milk yield is supported by a greater forage resource. Consequently, unless calf survival is adversely affected, weaner productivity could be enhanced by restricting the mating season to ensure calvings early in the rainy season by December.

Appropriate emphasis on weaning weight varies depending on the production system. Weaning weight is important for cow-calf producers because it monitors their primary product (Roberson et al., 1986). The maternal abilities of cows mostly affect the weaning weights of their calves through the milk produced (Koch, 1972; Lasley, 1972). In this sense, weaning weight is a measure of cow productivity. However, in extensive production systems such as those in southern Mozambique (e.g., partly concealing effects of season of birth on body weights at birth and weaning, and 3 to 4 yr for animals to reach market weight), weaning weight probably should receive relatively less emphasis than 18-mo weight (Dionisio, 1989). Weight at 18 mo is the frequent criterion for animal management decisions including breed choice.

*Weight at 18 Months.* Breed, sex, and year-season affected ( $P < .01$ ) weight at 18 mo (Table 3), but age

of dam, parity, and the random effect of sire were less important sources of variation than at earlier ages. Males averaged  $29 \pm 2.6$  kg (13%) heavier ( $P < .01$ ) than females weighing 232 kg. Age of dam was important only for birth weight. This finding was consistent with other reports (e.g., Trail and Gregory, 1981; Tawonezvi, 1989) in which maternal influence diminishes after weaning, whereafter growth depends highly on the interactions between the animal's genotype with the surrounding environment, especially nutrition and health.

As for weaning weight, animals born early in the rainy season (Table 6) were  $17 \pm 3$  kg heavier than those born late in the rainy season ( $P < .01$ ). These results substantiate the management recommendation to concentrate calvings in the early rainy season by December, unless calf survival is reduced.

Africander calves averaged  $18 \pm 6$  kg heavier at 18 mo than Landim calves ( $P < .01$ ). Average 18-mo weights were 237 kg for Landim and 255 kg for Africander calves.

Africander calves were heavier than the Landim ones at all early ages: birth, weaning, and 18 mo. However, the relative breed difference, estimated by the percentage difference between Africander and Landim  $[(\text{Africander weight} - \text{Landim weight}) \div \text{Landim weight}] \times 100$ , diminished with age. These percentage differences were 16, 9, and 7% for weights at birth, weaning, and 18 mo. Expressed as percentages of the within-breed standard deviation (SD), these weight differences between breeds were 105, 72, and 67% at birth, weaning, and 18 mo. The same trends in the percentage differences between breeds were found in the data subset containing animals that were weighed at each of these ages. The relative differences were 16, 11, and 9% as a percentage of Landim weight and 121, 90, and 84% as a percentage of within-breed SD. These results may indicate a compensatory adaptation by Landim calves to the nutritionally limited environment in which they were raised relative to the Africander breed.

*Preweaning and Postweaning Growth Rates.* Year-season and sex affected pre- and postweaning average daily growth ( $P < .01$ , Table 4). Breed affected preweaning growth ( $P = .07$ ) but sire/breed did not have an influence ( $P = .18$ ). Neither the effect of breed nor sire/breed was detectable in the postweaning period.

Contrary to other studies (Koch, 1972; Roberson et al., 1986; Tawonezvi, 1989), age of dam did not affect ( $P = .66$ ) preweaning growth. Mothering ability (judged from calf growth rate) was highly influenced by environmental factors, especially those contained (or confounded) in the year-season effect.

Calves born early in the rainy season had  $.017 \pm .004$  kg/d faster ( $P < .01$ ) postweaning growth than calves born late in the rainy season. This result further illustrates the advantages of restricting the breeding season to obtain calvings early in the rainy season. The sex difference in growth and body weight was consistent from birth to 18 mo ( $P < .01$ ). Males grew  $.036 \pm .008$  kg/d faster than females during the preweaning period and  $.053 \pm .007$  kg/d faster during the postweaning period.

Africander calves grew 8% faster ( $P < .05$ ) before weaning than Landim calves, whose average daily growth rate was  $.56 \pm .011$  kg/d. Growth from birth to weaning partly reflects the dam's maternal ability (e.g., milk yield). The average daily growth for the two breeds after weaning was  $.267 \pm .011$  kg for the Landim and  $.276 \pm .010$  kg for the Africander (Table 2). Therefore, the Africander and the Landim cattle grew at similar rates in this period ( $P = .56$ ). This result supports a hypothesis for relatively greater adaptation of the Landim calves to the climatic and nutritive environment prevailing at the Chobela station, especially after weaning. Growth after weaning in this environment depends on the interaction between the animal's genotype and nutrient apprehending opportunities and constraints (e. g., browsing and seasonal variation in available plant biomass).

*Body Weight at First Calving.* The average weight of these females at 18 mo of age by year-season of calving ranged from 205 kg to 239 kg, corresponding to average growth of 140 kg in approximately 2 yr. There was a distinct trend to lighter weights at first calving through time and without detectable interaction with breed. Hence, the average weight decrease (approximately 65 kg) was similar for both breeds. This decrease in weight at first calving may have been a consequence of management resulting in younger ages and lighter weights in heifers at first exposure to breeding. Other identifiable environmental effects did not change so dramatically to explain such differences in weight at first calving. Season of calving (early vs late rainy season) did not affect weight at first calving ( $P = .92$ , Table 5). Accounting for age at first calving ( $\bar{x} = 39.5$  mo for Landim and  $\bar{x} = 42.8$  mo for Africander) was important in reducing the error

variance ( $P < .002$ , Table 5).

Least squares means for weight at first calving after adjusting for age at first calving (Table 5) were  $378 \pm 19.3$  kg for Landim and  $370 \pm 14.6$  kg for Africander heifers. This linear contrast was not significant ( $P = .74$ , Table 5). The large difference of 3 mo in average age at first calving between Landim and Africander heifers accounted for 48% of the variation in weight at first calving or approximately two-thirds of the coefficient of determination for the full model ( $R^2 = .71$ ).

Differences between age-adjusted body weights for the Landim and Africander calves showed a diminishing trend when compared on a percentage basis. Body weight differences favoring Africander calves tapered from 16% at birth to 7% at 18 mo of age and were undetectably small (2%) by first calving. This trend was confirmed in the subset of 52 animals with body weight records at all ages. As suggested previously, these results may indicate relatively greater adaptation by the Landim to the nutritionally limited environment prevailing in southern Mozambique.

## Implications

Africander calves were heavier than Landim calves at birth, weaning, and 18 mo, but there was no detectable difference for age-adjusted body weight at first calving and postweaning daily growth rate. Diminishing differences in weight and growth with advancing age indicates relatively greater adaptation by earlier-maturing Landim than by Africander cattle. This adaptive mechanism may compensate for the lighter body weights (and beef yield per animal unit) if accompanied by further reproductive advantage besides earlier fecundity. Consequently, there is need to examine the comparative reproductive rates and the corresponding beef offtake per reproducing female in these environmental conditions.

## Literature Cited

- Barlow, R. 1984. Selection for growth and size in ruminants: Is it time for a moratorium? In: Proc. 2nd World Congr. Sheep and Beef Cattle Breed. pp 421-432. Pretoria, South Africa.
- Buck, N. G., D. Light, A. Rutherford, M. Miller, T. W. Rennie, D. Pratchett, B. S. Capper, and J.C.M. Trail. 1976. Environmental factors affecting beef cow reproductive performance in Botswana. *Anim. Prod.* 23:357.
- Carvalho, J.G.V. 1992. Comparison of the Landim and Africander cattle in southern Mozambique for growth, reproduction and total performance. M.S. Thesis. Cornell Univ., Ithaca, NY.
- Dionisio, A. C. 1989. Evaluation of growth and reproductive performance of Nguni and Africander cattle in Chobela Research Station - Mozambique. M.S. Thesis. Agricultural University of Norway, Oslo.
- Dionisio, A. C., and O. Syrstad. 1990. Productivity of Nguni and Africander cattle in Mozambique. *Livest. Prod. Sci.* 24:29.
- Galina C. S., and G. H. Arthur. 1989. Review of cattle reproduction

- in the tropics. Part 1. Puberty and age at first calving. *Anim. Breed. Abstr.* 57(7):583.
- Koch, R. M. 1972. The role of maternal effects in animal breeding: VI. Maternal effects in beef cattle. *J. Anim. Sci.* 35:1316.
- Lasley, J. F. 1972. *Genetics of Livestock Improvement* (2nd Ed.). Prentice-Hall, Englewood Cliffs, NJ.
- Littell, R. C., R. J. Freund, and P. C. Spector. 1991. *SAS System for Linear Models* (3rd Ed.). p 105. SAS Inst. Inc., Cary, NC.
- Mason, I. L., and J. P. Maule. 1960. The indigenous livestock of eastern and southern Africa. Commonwealth Agriculture Bureaux, Slough, U.K.
- Maule, J. P. 1973. The role of the indigenous breeds for beef production in southern Africa. *S. Afr. J. Anim. Sci.* 3:111.
- Roberson, R. L., J. O. Sanders, and T. C. Cartwright. 1986. Direct and maternal genetic effects on preweaning characters of Brahman, Hereford and Brahman-Hereford crossbred cattle. *J. Anim. Sci.* 63:438.
- SAS. 1985. *SAS User's Guide: Statistics* (Version 5 Ed.). SAS Inst. Inc., Cary, NC.
- Scholtz, M. M. 1988. Selection possibilities of hardy beef breeds in Africa: The Nguni example. In *Proc. 3rd World Congr. Sheep and Beef Cattle Breed.* pp 303-319. Paris, France.
- Silva, J.M.P. 1966. *Subsidios para o estudo genético e fisiológico da produção de leite em Moçambique ao sul do Save*. Ph.D. Dissertation. Estudos Gerais Universitários, Mozambique.
- Tawonezvi, H.P.R. 1989. Growth of Mashona cattle on range in Zimbabwe. I. Environmental influences on liveweight and weight gain. *Trop. Anim. Health Prod.* 21:37.
- Tawonezvi, H.P.R., H. K. Ward, J.C.M. Trail, and D. Light. 1988. Evaluation of beef breeds for rangeland weaner production in Zimbabwe. 1. Productivity of purebred cows. *Anim. Prod.* 47:351.
- Trail, J.C.M., N. G. Buck, D. Light, T. W. Rennie, A. Rutherford, M. Miller, D. Pratchett, and B. S. Capper. 1977. Productivity of Africander, Tswana, Tuli and crossbred beef cattle in Botswana. *Anim. Prod.* 24:57.
- Trail, J.C.M., and K. E. Gregory. 1981. Sahiwal cattle: An evaluation of their potential contribution to milk and beef production in Africa. *ILCA Monograph* 3. Addis Ababa, Ethiopia.