The reproductive responses of two breeds of beef cows and the performance of their progeny in two contrasting environments

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The experiment was carried out over three seasons during which a total of 889 Afrikaner and 805 Simmentaler 'cow years' were studied. Nucleus breeding herds of each of these breeds were maintained at stations in the Highland Sourveld and the Valley Thornveld. At weaning, half of the progeny of each breed were transferred to the alternate location; the other half were retained at their original location. Afrikaner and Simmentaler cows had calving rates of 53,59% and 58,85% respectively in the Thornveld and 65,82% and 76,24% in the Sourveld. Significantly more Afrikaner (44%) and Simmentaler (21%) calves were weaned in the Thornveld than the Sourveld. Breed and feed situation (stalls vs. veld) had a highly significant effect ($P < 0{,}01$) on ADG from weaning to final mass. Both the Simmentaler and the Afrikaner calves consumed significantly more DM/kg gain in the Sourveld, than their counterparts in the Thornveld.
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'n Totaal van 889 Afrikaner en 805 Simmentaler 'koei-jare' is oor drie seisoene bestudeer. Kernkuddes van Simmentaler en Afrikaner koeie is op stasies in die Hoogland-suurveld en die Vallei-doringveld onderhou. Die helfte van die kalwers van elke ras is met speentyd na die alternatiewe lokaal verplaas. Die ander helfte is op hul geboorteplaas gehou. Afrikaner en Simmentaler koeie het onderskeidelik kalfpersentasies van 53,59% en 58,85% in die doringveld, en 65,82% en 76,24% in die suurveld gehad. Meer Afrikaner (44%) en Simmentaler (21%) kalwers is in die doringveld as in die suurveld gespeen. Ras en voerplek (stalle vs. veld) het 'n hoogs betekenisvolle ($P < 0{,}01$) effek uitgeoefen op die GDT van speen tot finale massa. Beide die Simmentaler en die Afrikaner diere het betekenisvol meer DM/kg massatoename in die suurveld ingeneem.
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Introduction

Most of the environmentally orientated research with beef cattle, in South Africa, has concentrated on the effects of heat stress and related problems (Bonsma, 1949; Bonsma, 1980). This is understandable because most of the important beef-producing areas experience either tropical or sub-tropical climates. Consequently, the effects of cold stress on beef production in the cooler, moister areas have largely been overlooked. The question may legitimately be asked whether cold stress is a problem in this country, and if so, to what extent? This particular question is pertinent in situations where cattle are moved from the Sourveld to the Thornveld areas during the winter months. Unfortunately, little is known or understood about the responses of beef cattle to translocation from one bioclimatic area to another.

In 1957 Bonsma & Joubert advocated a regionalized beef production system. They suggested that certain bioclimatic areas are better suited to breeding animals, whilst other areas closer to supplementary feed sources and markets, could probably be used better for the growing-out and finishing of beef animals.

The purpose of this paper is therefore two-fold. Firstly, an attempt is made to provide some biological evidence upon which decisions can be made regarding regionalized beef production. Secondly, this paper attempts to quantify the effects of stress, particularly cold stress, on traits of economic importance.

Procedure

Experimental sites

The two sites chosen for the experiment were the Thabamhlope Research Station — representative of Highland Sourveld and falling within Bioclimate area 4e, and the Onverwacht Research Station — representative of Lowland Thornveld and contained in Bioclimate area 10 (Philips, 1973).

Topography

The veld area classified as Highland Sourveld is approximately 1,83 million hectares in extent or 20,59% of the total area of Natal. Eighty-eight per cent (1,61 m ha) of the Highland Sourveld is natural grassland. The veld area assigned to the experiment consisted of gently rolling hills with a general absence of trees and bushes. The animals were therefore exposed to the prevailing Berg wind conditions. The altitude of the experimental area varies between 1457 and 1524 m above sea level.

The Thornveld area of Natal covers an area of 1,84 million hectares. Approximately 76% of the total area is covered by grasslands and about 23,5% is under cultivation. The area used for the experiment varied between flat open areas with occasional bushes to areas where grass cover was good and thornbushes averaging 3,5 m in height were abundant. Adequate shade and protection were therefore available at all times.

Daily rainfall measurements were used to calculate mean monthly figures. Temperature and humidity figures were collected at 08h00 and 14h00 each day.

Experimental animals

Breeding herds

Nucleus breeding herds of Simmentaler and Afrikaner cows were maintained at each location. Eight hundred and eighty-nine Afrikaner and 805 Simmentaler 'cow years' were studied over three seasons. The mating season extended from the 1st of December to the end of February. The bulls were rotated between the two stations on a fortnightly basis in an attempt to reduce the genetic affect of the sire. The bull to cow ratio was 1:25.

Calves

A total of 457 Simmentaler and 398 Afrikaner calves were involved during the 3-year experimental period. Weaning took place during May and June. At weaning half of the calves of each sex and breed were translocated to the alternate location. The other half were retained at their original location. At each location, half of the calves were allocated to the veld treatments, whilst the other half were fed in stalls. The stalls were constructed to allow individual penning of the animals so that accurate feed intake recordings were facilitated.

Feed regimes

Cows

Cows cannot maintain body mass during the winter months (May – September) on Highland Sourveld. Consequently, at weaning the cows were transferred to open kraals where they were fed conserved feed. During the first season the cows in the Sourveld were fed veld hay *ad lib.* plus 2,3 kg lucerne hay per head. These animals also had access to a NPN lick. The basic diet was changed for the second and third seasons for two reasons. Firstly, lucerne hay was becoming increasingly difficult to obtain and secondly, it was felt that the diet should be more in keeping with the potential of the area. The diet became one consisting of *Eragrostis curvula* hay, fed *ad lib*; 10 kg/head grass silage and an NPN lick which was freely available. In the Thornveld, the cows remained on veld during the winter months, but had NPN blocks freely available.

In both the Sourveld and the Thornveld, a molasses-based lick was available between September and January. The intake was restricted to between 0,68 and 0,77 kg per head per day.

Calves

During the first season the calves fed in the stalls received a basic diet consisting of *E. curvula* hay fed *ad lib.*, lucerne hay fed at the rate of 2,3 kg per head per day and 0,5 kg maize meal. The calves' diets were also changed after the first season. The diet for the following two seasons consisted of *E. curvula* hay (*ad lib.*), 3,2 kg/head/day maize meal and 0,5 kg per head high protein concentrate (HPC). The composition of the HPC was adjusted within three live mass categories concomitant with the animal's changing nutritional requirements. The three categories were: weaning – 273 kg; 274 kg – 364 kg; 365 kg – slaughter.

In the Sourveld the calves in the veld-grazing treatments were moved to open kraals during the winter months and fed *E. curvula* hay, grass silage plus an NPN lick. The calves in the Thornveld remained on veld, but were supplied with NPN blocks.

Afrikaner steers were raised to a mass of approximately 410 kg, and Simmentaler steers to a mass of 455 kg before being slaughtered. The Simmentalers required additional feeding in order to achieve the necessary 'finish' for the top grades. Heifers were raised to a mass of about 318 kg, the mass at which they were assumed to attain puberty. Heifers not absorbed into the breeding herd were culled.

Diet components

Roughages

The *E. curvula* hay used in the experiment was grown at the Thabamhlope Research Station. Each cut of hay was equally divided between the two stations, to ensure, as far as possible, uniform quality at each location. Lucerne hay was purchased from a single source and equally divided between the two stations. Samples of both *E. curvula* and lucerne hay were analysed for crude protein (CP) on a regular basis. Veld samples were cut and analysed on a weekly basis for CP.

Statistical analyses

Factors affecting mass 12 months after weaning and average daily gain (ADG) from weaning to final mass were analysed by multiple regression analysis. Analysis of covariance were used to correct for differences in weaning mass. Each season was analysed separately in three single analyses. In the fourth analysis all the data were pooled and season was then included as an independent variate.

Results and Discussion

Climatological data

Rainfall

In the Sourveld, 70% of the annual rainfall is recorded between December and March (Natal Ag. Met. 1979/80 – 1983/84). Recordings at the Thabamhlope Research Station indicated that the mean annual rainfall over the experimental period was 854 mm. The rainfall distribution in the Thornveld was similar to that in the Sourveld. However, the mean annual rainfall was only 605 mm, 250 mm per annum less than that recorded in the Sourveld.

Temperature

Mean maximum temperatures during the summer in the Thornveld were in the order of 33,5°C and winter mean minimum temperatures between 4 and 6°C. In the Sourveld, mean maximum temperatures ranged between 26 and 30°C and winter minimum temperatures between −3 and 0°C. Extreme temperatures of 34,5°C and −4°C were recorded on individual days but never for long periods at a time. It is important to note that the Sourveld experiences mean minimum temperatures below 10°C for 7 months of the year (April – October), whilst similar temperatures are experienced in the Thornveld from May to August; a period of only 4 months.

Effective ambient temperature (EAT) is an index used to describe the collective thermal impact of the animal's total environment (NRC, 1981). Such an index has become necessary because animals are exposed to and affected by several components of the climatic environment. The most important factors, in addition to air temperature, include thermal radiation, humidity, air movement, contact surfaces and precipitation.

The importance of air movement is particularly significant in the present study. Extrapolating from results presented by Bowden, Hironaka, Martin & Young (1979), it appears that a wind speed of 25 km/h would reduce a still-air temperature of about 15°C to 4°C, which is the lower limit of the acceptable temperature range (4 – 26°C) suggested for beef cattle for minimum production (Hahn, 1974). The EAT would, however, be considerably lower than 4°C and consequently, the effect on production could be even more severe. It must be emphasized that this paper is more concerned with EAT's that affect production, which are considerably higher than the lower critical temperatures (LCT's) given for various classes of beef cattle (Young, 1981). Winter mean monthly temperatures in the Sourveld fall well within this 'stress' zone.

Quality of dietary components

The mean CP content of the *E. curvula* hay fed at Thabamhlope was 9,33% (± 1,01) and 9,37% (± 0,63) at Onverwacht. Lucerne hay averaged 15,32% (± 1,63) CP in the Sourveld and 14,04% (± 1,25) in the Thornveld. The veld analyses indicated a typical seasonal pattern, peaking in spring and reaching a low point during the winter. The mean CP of the veld samples in the Sourveld between October and March was 7,94% (± 1,20) and 3,38% (± 0,79) between April and September. In the Thornveld the mean CP content of the grass sampled between October and March was 6,61% (± 1,25) and between April and September 3,50% (± 0,75).

Breeding cow herds

Calving rates

Data reflecting the number of cows that calved and the number of calves weaned are presented in Table 1. Calving rates were disappointingly low, particularly in the Thornveld. A number of factors are possibly responsible for these low calving percentages. Lamond (1970) has suggested that each cow has an optimum body mass for conception. The ability of a cow to reproduce decreases as body mass declines below this target mass. Steenkamp, van der Horst & Andrew (1975) found that post-partum mass in Afrikaner cows was the most significant factor influencing reconception. Figures 1a and 1b show the mean (3 years) live mass changes (expressed over a period of 12 months) of the lactating Afrikaner and Simmentaler cows involved in the experiment. The mass change patterns for the two breeds in the Sourveld are remarkably similar (Figure 1a). The Simmentaler cows lost 6,05% of their body mass during the calving season and the Afrikaner cows 8,18%. Average masses during the mating season were 415 kg for the Simmentalers and 410 kg for the Afrikaners. The difference in conception rate between the Simmentalers and the Afrikaners (10,42%, Table 1) cannot therefore be easily explained by large differences in mass gain, mass loss or even actual body mass at the time of mating.

The mean mass changes of the cows in the Thornveld show a far more dramatic trend (Figure 1b). Afrikaner cows lost 7,69% of their body mass during the calving season, compared to a loss of 14,9% in the Simmentalers. Consequently, the average mass during the breeding season was 375 kg for the Afrikaners and 363 kg for the Simmentalers. This is 9,0 and 13,0% less respectively, than their counterparts in the Sourveld. The difference in mass between the cows in the Sourveld and the Thornveld at mating could account for the differences in conception rates between the two areas (Table 1). Although both breeds gained in mass during the breeding season, it is likely that many of the cows never achieved the target mating mass necessary for reconception (Lamond, 1970; Meaker, 1975).

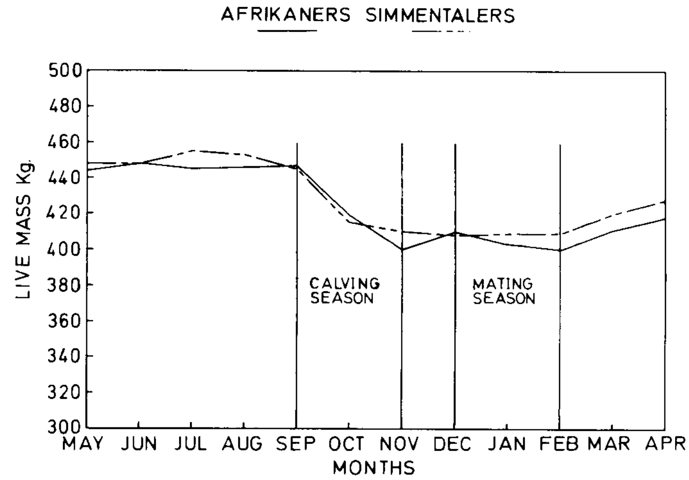

Figure 1a Mean mass changes of lactating cows which reconceived on the Sourveld

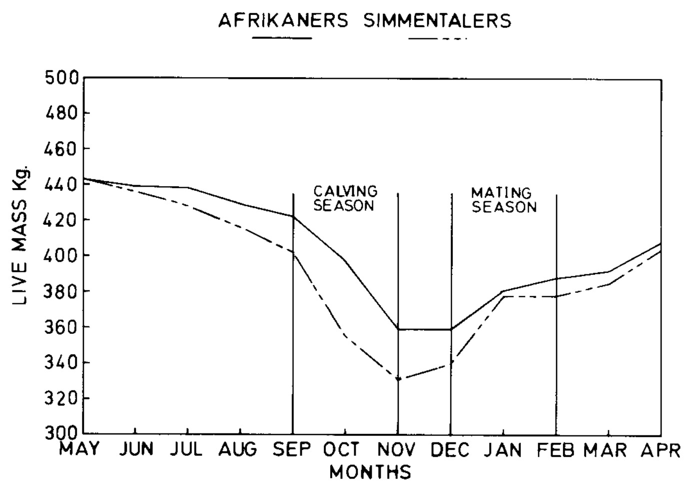

Figure 1b Mean mass changes of lactating cows which reconceived on the Thornveld

Table 1 Calving and weaning rates of Afrikander and Simmentaler cows in the Sourveld and Thornveld areas during the experimental period (3 years)

Area	Breed	Cows bred	Cows calved	%	Calves weaned	%
Sourveld	Afrikander	471	310	65,82	194	62,58
	Simmentaler	421	321	76,24	246	76,64
Thornveld	Afrikander	418	224	53,59	204	91,07
	Simmentaler	384	226	58,85	211	93,36

The data in Table 1 also show that the number of calves weaned in the Thornveld was significantly higher than in the Sourveld, despite the fact that the calving rates of both breeds were considerably higher in the Sourveld than the Thornveld. The high mortality rate of calves in the Sourveld can perhaps be ascribed to the climatic conditions prevailing during the early part of the calving season.

The mean temperature and rainfall recorded for September in the Sourveld was 15°C and 60 mm respectively. These factors combined with the strong cold winds normally encountered during this time of the year, would have reduced

Table 2 Post-weaning performance of Simmentaler (S) and Afrikaner (A) heifers fed in stalls and on veld at two locations

Origin	Location	Breed	Feed location	Corrected 12 months post-weaning mass	ADG weaning to final mass
Sourveld	Sourveld	Simm	Stalls	293,83 ± 7,31	0,38 ± 0,03
Sourveld	Thornveld	Simm	Stalls	253,20 ± 11,57	0,42 ± 0,03
Thornveld	Thornveld	Simm	Stalls	309,45 ± 10,11	0,42 ± 0,04
Thornveld	Sourveld	Simm	Stalls	285,97 ± 30,99	0,36 ± 0,01
Sourveld	Sourveld	Afrik	Stalls	274,91 ± 30,50	0,31 ± 0,03
Sourveld	Thornveld	Afrik	Stalls	299,79 ± 19,04	0,37 ± 0,04
Thornveld	Thornveld	Afrik	Stalls	293,95 ± 22,06	0,34 ± 0,04
Thornveld	Sourveld	Afrik	Stalls	253,33 ± 18,61	0,25 ± 0,04
Sourveld	Sourveld	Simm	Veld	271,92 ± 43,82	0,31 ± 0,04
Sourveld	Thornveld	Simm	Veld	273,20 ± 0,55	0,27 ± 0,06
Thornveld	Thornveld	Simm	Veld	276,87 ± 9,35	0,29 ± 0,05
Thornveld	Sourveld	Simm	Veld	262,63 ± 49,36	0,30 ± 0,03
Sourveld	Sourveld	Afrik	Veld	232,44 ± 49,69	0,23 ± 0,03
Sourveld	Thornveld	Afrik	Veld	253,24 ± 17,12	0,26 ± 0,05
Thornveld	Thornveld	Afrik	Veld	253,55 ± 15,36	0,26 ± 0,05
Thornveld	Sourveld	Afrik	Veld	229,03 ± 35,61	0,21 ± 0,02

the still-air temperature to an effective 0 – 5°C. This figure is close to the lower critical temperature (LCT) given for new-born calves (Young, 1981). The highest incidence of calf mortality was noted during the peri-natal phase. Subsequent experience has verified the fact that high calf mortality coincides with low temperatures and high winds. It is however unlikely that climatic effects *per se* would result in the death of new-born calves. A more reasonable explanation is that particularly cold spells lower the resistance of new-born calves, making them more susceptible to *E. coli* infection and Coccidiosis. This point however, requires further investigation. These data show unambiguously that both breeds had higher calving rates in the Sourveld than the Thornveld, but that a greater number of calves were weaned in the Thornveld (Table 1). These results appear to support the hypothesis proposed by Bonsma & Joubert (1957). It is equally clear that management is a significant factor under these conditions. Manipulation of the physical or managerial environment to enhance animal productivity is a potentially important tool for use by animal scientists.

Calf performance

Mass 12 months after weaning

The mass of the animals 12 months after weaning was considered to be important. It was assumed that by this stage the translocated animals would have had sufficient time to adjust to their respective environments. This parameter therefore served as a measure of adaptability to the specific environments.

Breed and weaning mass were found to be highly correlated ($P < 0{,}01$; r value $-0{,}744$). It was important in these analyses to establish the precise role that breed played in affecting post-weaning performance. Breed was therefore included as an independent variate in the analyses. Weaning mass was excluded. The variates included in the regression analyses were breed (X_1), stalls/veld (feed situation, X_2), location (X_3), origin (X_4), and season (X_5).

Breed accounted for between 36,1% (season 1) and 60% (season 3) of the variation in Y (mass 12 months after weaning; Table 3). The effect of breed in all four analyses was highly significant ($P < 0{,}01$). These results substantiate the concept of selecting the right type of animal for certain environmental conditions.

The animals fed in the stalls would be expected to have higher mass gains than the animals on natural veld for two basic reasons. Firstly, the CP's of the conserved feed were higher than those of the natural veld; there was also no seasonal variation. Secondly, the animals on veld were far more susceptible to environmental elements than the animals in the stalls. It is not surprising therefore that the feeding situation (S/V, X_2) accounted for between 30,7% (season 1) and 12,5% (season 2) of the variation in Y.

Table 3 Regression equations of factors affecting mass 12 months after weaning

Season 1	$Y = 260{,}9 - 28{,}10\ X_1 - 25{,}92\ X_2 - 18{,}25\ X_3 + 7{,}59\ X_4$
Season 2	$Y = 284{,}24 - 28{,}05\ X_1 - 12{,}78\ X_2$
Season 3	$Y = 300{,}25 - 24{,}21\ X_1 - 21{,}51\ X_2$
Pooled data Seasons 1 – 3	$Y = 281{,}53 + 26{,}79\ X_1 + 20{,}07\ X_2 + 30{,}08\ X_3 + 8{,}95\ X_4 + 6{,}15 X_5$

X_1 = breed, X_2 = stalls/veld (S/V), X_3 = location, X_4 = origin, X_5 = season

When the data were pooled, location (X_3) and origin (X_4) had small, but significant ($P < 0{,}01$) effects on the mass 12 months after weaning. These trends are clearly evident in Table 2. Irrespective of breed and feed situation, animals born and raised in the Thornveld had higher 12 month post-weaning masses than animals born in the Thornveld and raised in the Sourveld. However, it is also clear from these data (Table 2), that animals raised in the Thornveld consistently had higher masses 12 months post-weaning than animals located in the Sourveld, with origin apparently playing a relatively minor role. Origin (X_4) contributed only 1,9% to the variation in Y. A total of 77,3% of the variation in Y was accounted for by the five parameters measured.

Average daily gain (ADG) from weaning to final mass

Final mass for the heifers is defined as the mass at which the animals were withdrawn from the trial and introduced into the breeding herd. The mass was in the region of 318 kg. The feeding situation, stalls vs. veld (X_1) had a highly significant ($P < 0{,}01$) effect on ADG from weaning to final mass (Y),

Table 4 Regression equations of factors affecting ADG (Y) from weaning to final mass

	Season			
	1 %R^2	2 %R^2	3 %R^2	1 – 3 %R^2
Stalls/veld (X_1)	20,6	47,3	32,0	32,1
X_1 + breed (X_2)	54,2	55,8	49,3	49,8
$X_1 + X_2$ + location (X_3)	55,5	61,2	50,4	52,0
$X_1 + X_2 + X_3$ + orogin (X_4)	57,6	61,3	51,5	52,7
*$X_1 + X_2 + X_3 + X_4$ + + season *(X_5)				53,5
Season 1	$Y = 0{,}357 - 0{,}033X_1 - 0{,}042X_2$			
Season 2	$Y = 0{,}363 - 0{,}053X_1 - 0{,}022X_2$			
Season 3	$Y = 0{,}340 - 0{,}047X_1 - 0{,}035X_2$			
Season 1 + 2 + 3	$Y = 0{,}353 - 0{,}044X_1 - 0{,}033X_2 - 0{,}011X_3$			

*The data for seasons 1, 2 & 3 were pooled and season added as an independent variate (X_5)

accounting for between 20,6% (first season) and 47,3% (second season) of the variation in Y (Table 4).

A relatively small contribution (20,6%) to the variation in ADG was made by stalls/veld, whilst breed accounted for 33,6% of this variation, during the first season. This suggests that, when the effect of feeding site was reduced, the breed effect could be fully expressed. However, during the second season, although breed may still have been an important factor, the breed effect was supressed by the strong influence of the feeding site (S/V), which accounted for 47,3% of the variation in Y (Table 4). These results indicated the possibility of an interaction between breed and S/V. However, these interactions were found to be non-significant, as were all other interactions tested for. In the first three regression analyses (Table 4) neither location nor origin made a significant contribution to the variation in Y. However, when the data were pooled, location made a small, but significant ($P < 0{,}05$), contribution to the variation in ADG. The effect of origin was non-significant. When the two breeds and the two feeding situations were compared on a location basis (i.e. excluding origin), the pooled data in Table 2 showed clearly that the Simmentaler and Afrikaner heifers fed in the stalls in the Thornveld, had 13,5% and 26,78% higher ADG's respectively than those in the Sourveld. Contrasting results were obtained in the veld situation. Simmentaler heifers raised in the Sourveld had an 8,92% ADG advantage over the Simmentalers running on Thornveld (Table 2). The Afrikaner heifers however, had an 18,18% higher ADG in the Thornveld than in the Sourveld (Table 2). The reasons for the difference in breed response to the veld situation are not clear.

Efficiency of feed utilization

Heifers

Simmentalers generally required less dry matter per kilogram live mass gain than the Afrikaners. The Simmentalers in the Thornveld proved to be the most efficient and the Afrikaners in the Sourveld the least efficient in terms of feed utilization (Table 5). Afrikaner heifers in the Sourveld consumed 35,63% more DM/kg live mass gain than their counterparts in the Thornveld, whilst the intake of the Simmentalers was 24,83% more DM/kg gain in the Sourveld than the Thornveld (Table 5). In the Thornveld, Afrikaner heifers took in 25,66% more DM/kg gain than the Simmentalers, whilst in the Sourveld, Afrikaner heifers consumed 36,53% more DM/kg gain than the Simmentalers. If location is ignored, Afrikaner heifers consumed 26,02% more DM/kg gain than the Simmentalers.

Steers

Afrikaner steers consumed 44,43% ($P < 0{,}01$) more DM/kg gain in the Sourveld than in the Thornveld (Table 5). The Simmentaler steers on the other hand consumed only 10,38% more DM/kg gain in the Sourveld. Afrikaner steers consumed 36,17% ($P < 0{,}01$) more DM/kg gain than the Simmentalers in the Sourveld. The difference between the two breeds in the Thornveld was, however, relatively small. When location is ignored, the feed consumption of the Simmentalers was on average 12,67 (± 1,34) kg DM/kg gain and for the Afrikaners 15,98 (± 2,98) kg DM/kg gain, a difference of 26,12% (NS).

Table 5 Dry matter intakes per kilogram live mass gain (DM/kg gain) for heifers and steers fed in stalls in two different climatological areas

Origin	Location	Breed	Sex	Dry matter intake per kg live mass gain kg
Sour	Sour	Simm	♂	13,22 ± 1,28
Sour	Thorn	Simm	♂	12,20 ± 0,84
Thorn	Thorn	Simm	♂	12,84 ± 1,14
Thorn	Sour	Simm	♂	14,42 ± 1,28
Sour	Sour	Afrik	♂	17,99 ± 1,54
Sour	Thorn	Afrik	♂	13,32 ± 0,93
Thorn	Thorn	Afrik	♂	12,75 ± 0,36
Thorn	Sour	Afrik	♂	19,66 ± 2,16
Sour	Sour	Simm	♀	13,56 ± 1,17
Sour	Thorn	Simm	♀	10,22 ± 0,68
Thorn	Thorn	Simm	♀	11,44 ± 0,24
Thorn	Sour	Simm	♀	13,48 ± 1,00
Sour	Sour	Afrik	♀	17,12 ± 1,62
Sour	Thorn	Afrik	♀	13,84 ± 0,76
Thorn	Thorn	Afrik	♀	13,39 ± 0,80
Thorn	Sour	Afrik	♀	19,80 ± 2,32

It is clear that the Afrikaners, irrespective of origin, had difficulty in adapting to conditions in the Sourveld (Table 2). This is not altogether surprising, because it is generally accepted that Afrikaner animals, whilst having excellent heat tolerance, are not cold tolerant. Simmentalers on the other hand, are only reasonably heat tolerant, but have good cold tolerance (Bonsma, 1977). Of the five parameters measured that were regarded as having a significant effect on mass 12 months after weaning, breed was the most significant. Although the effect of breed varied from season to season, it was always highly significant ($P < 0{,}01$; Table 3).

The heifers fed in the stalls had significantly higher 12 month post-weaning masses than the animals running on the veld. Once again these results are not unexpected because the animals fed in the stalls had better, more uniform quality feed, and more protection from the environmental elements, than the animals on the veld. The data in Tables 3 and 4 show only the mean (3 year) 12 month post-weaning masses and the mean (3 year) ADG's from weaning to final mass, but when attention is focused on production within a season, distinct seasonal variations in performance are evident. The highest mass gains were recorded during the summer periods and the lowest gains during the winter phases. These trends were observed in both the stalls and the veld situations. The seasonal response of the animals fed in the stalls is of particular interest since the quality of feed was not subject to seasonal variations. Research findings have indicated that 40 to 60% of the seasonal variation in feedlot performance can be attributed to climatic variables (Milligan & Christison, 1974; Ames, Brink & Schalles, 1975).

The results from this experiment show unequivocally that both the Simmentalers and the Afrikaners consumed significantly more DM/kg gain in the Sourveld than their counterparts in the Thornveld (Table 5). The effect of location was greater on the Afrikaners than the Simmentalers. It is axiomatic that an increase in total feed intake would mean an increase in energy intakes as well. An increased energy uptake would be necessary because maintenance energy requirements increase linearly during cold, but nonlinearly during heat stress (Ray, Hale & Marchello, 1969; Ames & Ray, 1983). However, maintenance energy requirements increase more rapidly than their rate of voluntary energy intake during cold (Ames & Ray, 1983). Consequently, if the ration is deficient in energy, beef animals could be under considerable stress to maintain normal body functions.

This research has revealed nothing new in terms of the ability of certain breeds to adapt to certain environmental conditions. It has however, drawn attention to the fact that in some instances, the synchronization of genetic resources with the environment may be a primary factor affecting productivity. This study has shown that mean monthly winter temperatures of between 5 and 10°C were sufficiently low to have had a significant effect on beef cattle performance. However, the effective ambient temperatures (EAT's; NRC, 1981) were probably substantially lower than the recorded still-air temperatures. The question then remains: to what extent should the environment be modified to improve animal performance? Hahn (1974) differentiated between two distinct areas of environmental manipulation. 'Protective' modification such as solar radiation shades or winter wind breaks. This type of modification would suffice in the case of animals maintaining body functions. However, as production levels increase, so environmental factors gain in importance relative to nutrition and genetics (Hahn, 1974). In these situations, modifications are necessary to improve the 'productive' function of the animal. Such modifications often involve costly buildings and shelters. The degree of environmental modification needed will depend on the availability of strategic facts for decision making.

Environmental physiology and animal performance must be viewed in proper perspective. 'The efficiency of animal production and the fundamental questions of physiology and health that underlie the efficiency of animal production are determined by interactions between measurable elements of genetics, nutrition and the environment. In simple terms we seek to achieve the right feed for the right breed in the right place' (Webster, 1983).

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