Biological and economical effects of different supplements given to beef cows on summer veld

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One hundred and twenty Simmentaler and 120 Afrikaner cows were randomly divided into four herds of each breed. Supplements were compared in terms of cow and calf performance and costs. Either a rumen-stimulating lick (RSL), which contained approximately 26% crude protein, or a dicalcium phosphate salt lick (DL) was given. Half of each lick group was allocated to a set of camps either on a meso/distrophic soil (MS) or on a eutrophic soil (ES). Herds were rotated between camps over a period of four years. Cows grazed *Cymbopogon–Themeda* summer veld and received the different licks from approximately January to April. Lick intake was highest during above-average rainfall seasons, on the ES and for the Simmentaler cows. Cows which received the RSL had improved mass gains ($P < 0.05$), higher average mass at the end of the lick phase ($P < 0.05$) and better average condition score ($P < 0.05$) than cows which received the DL. The Afrikaner cows ended the lick phase in a better ($P < 0.01$) condition than Simmentaler cows, irrespective of lick. Veld on the MS appeared to be superior to veld on the ES in this area as cows on the former had higher ($P < 0.05$) condition scores than cows on the latter, again irrespective of lick. Reproductive performance was not affected by supplement. Simmentaler cows maintained a noticeably better conception percentage than Afrikaner cows. It appeared that soil type had affected the conception percentage in Simmentaler cows as conception was somewhat better for cows on the MS. The only difference in progeny performance was recorded between breeds ($P < 0.01$). The high intake of the RSL compared to the DL (1 125 g/cow/d and 125 g/cow/d respectively), without improved reproduction and/or performance of the calves, makes the supplementation with a RSL during the summer uneconomical in this particular area. Guidelines for lick intakes are not adapted for breeds or frame sizes and can lead to the under or over utilization of the supplement.

Eenhonderd-en-twintig Simmentaler- en 120 Afrikanerkoeie is ewekansig aan vier kuddes van elke ras toegewys. Aanvullings is vergelyk in terme van koei- en kalfprestasie en lekkoste. 'n Rumenstimulerende lek (RSL), wat ongeveer 26% ruproteïen bevat het, of 'n dikalsiumfosfaatsoutlek (DL) is voorsien. Die helfte van elke lekbehandelinggroep is aan 'n stel kampe op 'n meso-/distrofiese grond (MG) of 'n eutrofiese grond (EG) toegewys. Kuddes is tussen kampe, oor 'n periode van vier jaar, roteer. Koeie het op *Cymbopogon–Themeda*-somerveld gewei en het die verskillende lekke vanaf ongeveer Januarie tot April ontvang. Lekinname was die hoogste gedurende seisoene met bogemiddelde reënval, op die EG en vir Simmentalerkoeie. Koeie wat die RSL ontvang het, het hoër massatoenames ($P <$ .05), hoër massa aan die einde van die lekfase ($P < 0.05$) en verbeterde kondisie ($P < 0.05$) gehad as die koeie wat die DL ontvang het. Die Afrikanerkoeie was na die lekfase in 'n beter kondisie ($P < 0.01$) as die Simmentalerkoeie, ongeag die lekbehandeling wat hulle ontvang het. Veld op die MG blyk beter te wees as veld op die EG in hierdie gebied aangesien koeie op eersgenoemde in 'n beter kondisie ($P < 0.05$) verkeer het as koeie op die laasgenoemde, weer eens ongeag lekbehandeling. Reproduksie is nie deur lekbehandeling beïnvloed nie. Simmentalerkoeie het 'n ooglopend beter herbesetting as Afrikanerkoeie gehandhaaf. Dit blyk dat grondtipe 'n invloed op die besetting van Simmentalerkoeie gehad het aangesien koeie op die MG 'n effens beter besetting as koeie op die EG getoon het. Die enigste verskil in die nageslag se prestasie was tussen rasse ($P < 0.01$). Die hoë inname van die RSL in vergelyking met die DL (1 125 g/koei/d en 125 g/koei/d onderskeidelik), sonder verbeterde reproduksie en/of kalfprestasie, maak aanvulling met 'n RSL op somerveld in hierdie gebied onekonomies. Riglyne vir lekinnames is nie vir ras of raamtipe aangepas nie.

Keywords: Beef cows, dicalcium phosphate, protein, summer veld, supplement.

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Introduction

Supplementary feeding of ruminants is largely based on the direct extrapolation of principles established by means of conventional, stall-based feed intake and digestibility trials. The validity of such extrapolation is questionable (De Waal *et al.*, 1981; De Waal, 1990). Likewise, results concerning the reaction of grazing ruminants to supplementary feeding in one geographical area cannot summarily be extrapolated to another area where different environmental conditions prevail (De Waal, 1990).

The nutritional quality of veld undergoes seasonal changes. Reyneke (1976) stated that energy content changes from spring (active growth) through to winter (dormancy). Du Toit *et al.* (1940) used hand-cut samples in an extensive study of the nutritional value of various veld types throughout the year. Protein and phosphorus content of all samples from grasslands taken during winter were below maintenance requirements. Many samples collected during summer from the same areas, contained barely sufficient levels of nutrients for maintenance.

Grazing ruminants, however, have the ability to graze selectively, selecting feed with a superior nutritional composition. Comparisons between hand-cut samples and oesophageal fistula samples have clearly demonstrated this ability (Engels, 1972; De Waal, 1979; Cilliers, 1984). The actual feed consumed, therefore, has a higher nutritive value than was previously believed, and upon which many of the supplementation guidelines were based. The pasture, however, must be managed in such a way that the animal is not forced to consume everything that is available. Du Plessis (1974), as quoted by Cilliers (1984), stated that the stock farmer's welfare is, to a large extent, directly dependent on the condition of his veld.

Reyneke (1976) found that the protein content of veld in the Highveld Region is subjected to periodic deficiencies during summer (September to February), depending on rainfall. Maximum rainfall coincides with the flowering stage of most grasses. This is followed by seed-set and nutrient translocation to the roots. The latter process dramatically decreases the nutritional value of the aerial parts of the grass (Louw, 1979).

Cows are expected to reconceive while in early to mid lactation and must also produce a heavy weaner. This together with the changing nutritive value of the veld during the summer motivated the use of a rumen-stimulating lick (RSL). Supplementation with an RSL containing nitrogen, energy and minerals, from the month following maximum rainfall, prevents mass loss and maintains production through improved microbial digestion and increased roughage intake (Louw, 1979; Cronjé, 1990).

This trial was performed to determine whether an RSL is economically and biologically feasible when compared to a dicalcium phosphate salt lick (DL) on *Cymbopogon–Themeda* veld found in the western parts of the Highveld Region (Acocks, 1975). It is important to note that the effects of supplementation must be reflected in terms of animal production. Positive body mass changes, increased reproduction and improved weaning percentages and weights are parameters to be used (De Waal, 1979). The returns in the aforementioned must, at least, compensate for the costs incurred in feeding supplements (De Waal, 1990).

Materials and Methods

The trial was conducted using 120 Simmentaler and 120 Afrikaner cows. The cows were initially stratified according to mass, age, calf performance, constitution and previous winter treatment. Each breed was divided, at random, into two herds of 60 cows each and allocated to either the RSL or the DL. Each lick treatment group was divided into two herds of 30 cows each and allocated to a set of camps on either a meso/distrophic soil (MS) or a eutrophic soil (ES).

Both licks were mixed locally. The RSL formulation was based on the composition of commercially available production licks. The composition of the RSL as well as the DL is presented in Table 1. Crude protein content of the RSL was approximately 26% of which 66% was derived from feed grade urea.

Table 1 Composition of a rumen-stimulating lick, a dicalcium phosphate and salt lick and winter lick fed to cows on veld

Lick component	RSL[1] (%)	DL[2] (%)	Winter (%)
Urea	6.0		22
HPC40[3]	12.5		
Maize meal	44.0		22
Dicalcium phosphate	7.5	50.0	22
Salt	30.0	50.0	34
Recommended intake (g/cow/d)	1 000	100	300

[1] Rumen-stimulating lick.
[2] Dicalcium phosphate salt lick.
[3] High protein concentrate (40% crude protein – urea free).

The area where the trial was performed is characterized by andesite and diabase ridges. Vegetation is typical of the northern variation of *Cymbopogon–Themeda* veld (Acocks, 1975) with a capacity during summer to maintain a stocking rate of 3 ha/LSU at the Highveld Region research facility at Potchefstroom. Long-term average annual rainfall is 620 mm with most of the precipitation occurring during the summer months (October to March).

Camps on both soil types were laid out with consideration to ecotope. Herds were rotated between sets of camps over years to reduce camp effects. Each herd was randomly assigned a set of five camps on one of the two soil types and was rotated between camps according to the principles of controlled selective grazing.

Figure 1 illustrates the yearly production sequence of the cows in the trial. All the cows received a maintainance supplement ('Potch-lick') during the winter. All cows received a DL from spring, through to the month of maximum rainfall,

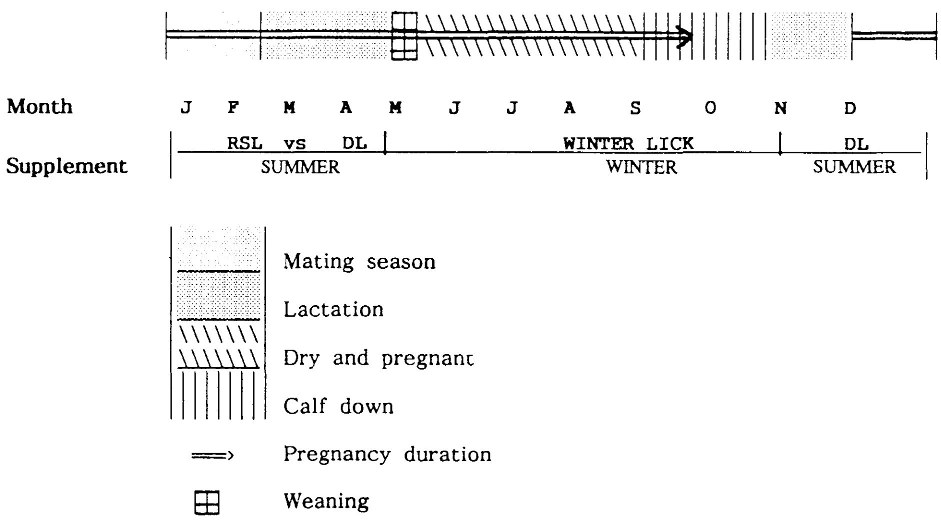

Figure 1 Production sequence and supplement management of beef cows at the Highveld Region experimental facility.

whereafter 50% of the cows received the RSL. Lick effect was examined during the latter part of the summer *per se*.

Cows were weighed annually at the start of the comparative lick phase (January) and at the end of this phase (May). Fasted body mass was determined after the cows had been left overnight without food or water (approximately 15 h). Cows were further compared in terms of condition score (scale of 1 to 5) and mass change during the lick phase. Reproductive parameters determined were percentages achieved in conception, calving and weaning. Cow numbers varied between 28 and 31 cows per herd. Measurements on the calves included average daily gain from birth (ADA), weaning mass and 205-day corrected weaning mass.

Lick intake of both supplements was accurately recorded on a herd basis. Supplements were supplied *ad libitum* and lick availability was monitored twice daily.

Oesophageal fistula samples were collected from representative camps prior to grazing. Samples were analysed for crude protein (CP) (micro-Kjeldahl method) and *in vitro* dry matter digestibility (IVDMD) (Tilley & Terry, 1963, as modified by Engels & Van der Merwe, 1967).

The economic viability of supplementing breeder cows with the RSL was tested in terms of supplement costs and the comparative animal production attained as compared to the DL. The data were analysed in a 2 × 2 × 2 × 4 factorial design, representing two supplements, two breeds, two soil families over a period of four years, with the aid of the Genstat (1987) program.

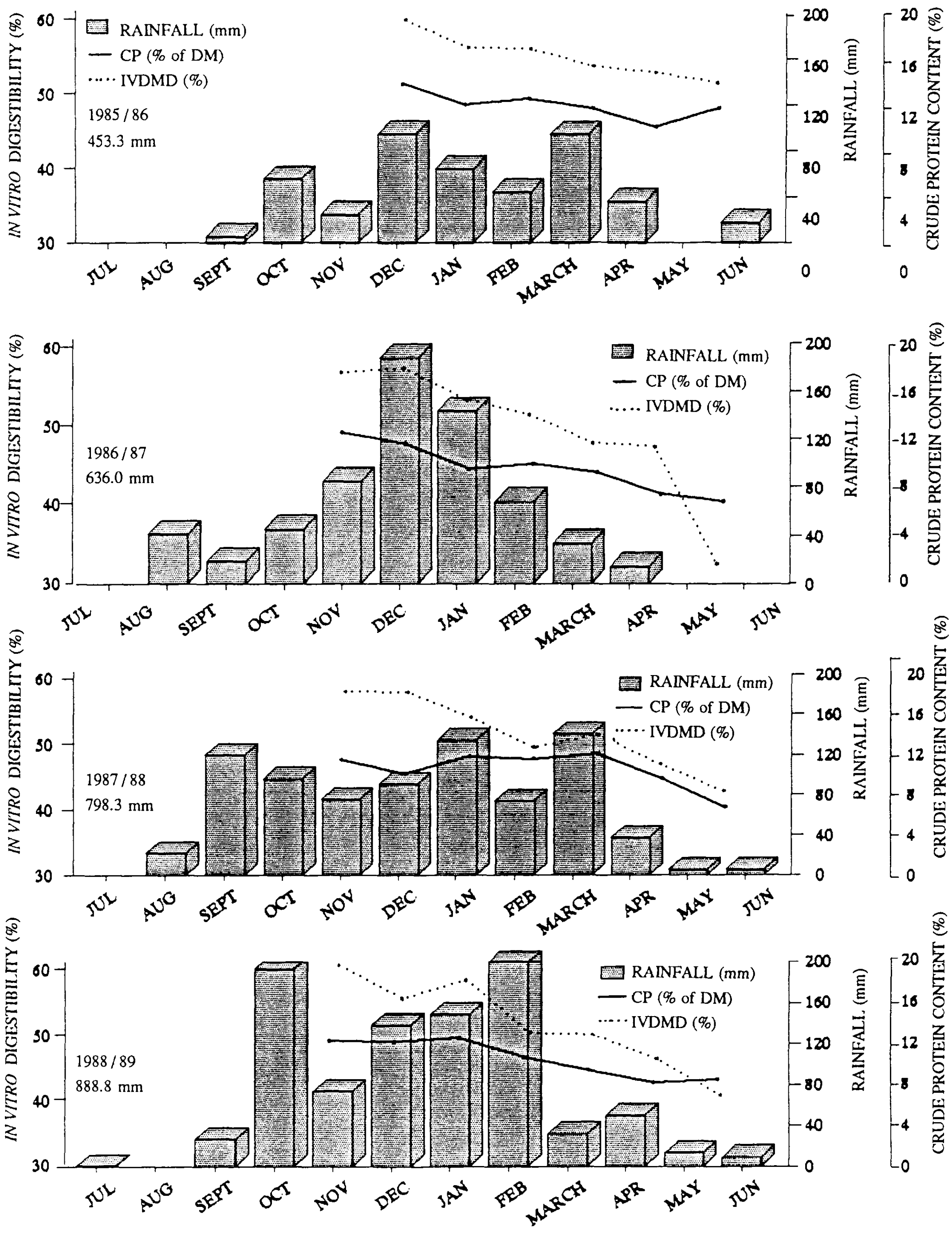

Figure 2 Rainfall, *in vitro* dry matter digestibility and crude protein content of oesophageal fistula samples collected prior to grazing.

Results and Discussion

Figure 2 indicates the IVDMD and CP content of oesophageal fistula samples collected prior to grazing. Each season is represented separately in the rainfall histogram to enable a comparison between rainfall and the nutritional value of the veld. It is evident that the 1985/86 season was reasonably dry while the remaining seasons had above-average rainfall.

During the years of higher rainfall (1986/87—1988/89), IVDMD declined gradually from November to March as was also found by Cilliers (1984). The decline in IVDMD from March to May was more rapid. It appears, therefore, that veld grasses mature more quickly during wetter seasons.

In 1985/86 the CP content never fell below 10% of dry matter (DM) during the trial period. For seasons with above-average rainfall, CP content of the samples was approximately 6.5% of DM during May as was also found by Cilliers (1984).

Rainfall distribution during the trial period was somewhat erratic with no specific month identifiable as the month of maximum rainfall. One can commence earlier with summer supplementation when the previous summer season had above-average rainfall together with sufficient spring rains, as the grass starts to grow and develop earlier during these seasons.

Table 2 shows the lick intakes of the two breeds grazing veld on two different soil types. Average lick intake over the four trial periods is also shown, according to which the average cost per cow per day was calculated (July 1991 prices of lick ingredients). There was a marked difference between breeds regarding the intake of both the DL and the RSL. The Afrikaner cow used 48 to 57% and 43 to 52% less of the DL and the RSL respectively, than the Simmentaler cow depending on the soil type they were on.

Lick intake was generally higher on ES. It would, therefore, appear that the nutritive value (quantity and/or quality) of veld on the ES is inferior to that of veld on the MS in this area.

A marked increase in lick intake occurred from the 1985/86 to the 1986/87 season. This corresponded with a higher rainfall during the latter season (Figure 2). Intake during the following season (1987/88) remained high and even increased in certain cases. During the final season (1988/89) the rainfall was the highest recorded during the trial (Figure 2). Despite this, RSL intakes declined rather dramatically. The intake of DL declined for the Simmentaler cows but increased for the Afrikaner cows. A possible reason for the general decrease is that the licks were constantly wet which may have affected the palatability thereof.

On average the Simmentaler cows consumed too much supplement and a general guideline is that the DL and the RSL should be utilized at 100 and 1 000 g/cow/d respectively. Despite the fact that both breeds received identical licks, the Afrikaner cows did not consume sufficient levels of supplements in terms of the general guidelines. The high level of intake of the RSL as compared to the DL makes the provision of the RSL very expensive, despite the fact that the RSL costs approximately 10c/kg less than the DL.

The period that the animals were given access to the licks differed annually, as the initiation and conclusion of the lick phase was prescribed by the development of the veld.

The values in Table 3 reflect the four-year average of the reproductive performance of the cows in the trial. Calving percentage does not reflect the number of calves born to cows mated in the original herds, as non-pregnant cows were replaced with pregnant heifers. As herds numbered 30 cows, single-sire mating was practiced with bulls exchanged at mid mating season.

The only noticeable difference between breeds occurred in conception percentage where Simmentaler cows recorded higher conception rates than Afrikaner cows. These percentages were achieved with a limited mating season of 63 days and include cows which had to conceive for the second time. It appeared that soil type also had influenced the conception percentage of Simmentaler cows as cows on MS had a slightly higher conception than those on ES.

Reproduction was not affected by the supplement which the cow received.

Table 2 Intake of either a dicalcium phosphate salt lick or a rumen-stimulating lick by beef cows grazing summer *Cymbopogon–Themeda* veld (1986—1989)

			Lick intake (g/cow-calf unit/d)				Four-year average	
Breed[1]	Soil[2]	Lick[3]	1985/86	1986/87	1987/88	1988/89	Intake (g/cow/d)	Costs[4] (c/cow/d)
Sim	MS	DL	149	227	197	129	173	9.34
		RSL	1 004	1 862	1 405	1 111	1 339	60.43
	ES	DL	140	158	184	175	164	8.86
		RSL	1 343	1 787	1 951	1 301	1 609	72.61
Afr	MS	DL	55	86	57	107	74	4.00
		RSL	418	656	733	741	636	28.70
	ES	DL	60	91	83	118	86	4.64
		RSL	685	1 130	1 122	741	917	41.38
Date of commencement			13/1/86	21/1/87	5/1/88	12/1/89		
Period (d)			100	80	99	88		

[1] Breed: Sim = Simmentaler; Afr = Afrikaner.

[2] Soil: MS = Meso/distrophic soil; ES = entrophic soil.

[3] Lick: DL = Dicalcium phosphate salt mixed on 1 : 1 ratio; RSL = rumen-stimulating lick – 26% crude protein.

[4] Costs: DL = 54.0 c/kg; RSL = 45.13 c/kg (July 1991).

Table 3 The reproductive performance of beef cows which received different summer supplements (Potchefstroom: 1986—1989)

Breed[1]	Soil[2]	Lick[3]	Conception[4] (%)	Calf[5] (%)	Wean[6] (%)
Sim	MS	DL	91.6	96.6	89.1
		RSL	90.8	94.2	86.2
	ES	DL	87.0	98.3	91.5
		RSL	86.9	97.4	89.6
Afr	MS	DL	81.0	96.5	89.7
		RSL	80.4	93.4	83.3
	ES	DL	80.5	97.7	87.1
		RSL	81.0	98.9	93.1

[1] Breed: Sim = Simmentaler; Afr = Afrikaner.

[2] Soil: MS = Meso/distrophic; ES = entrophic.

[3] Lick: DL = Dicalcium phosphate salt lick (mixed ratio of 1 : 1); RSL = rumen-stimulating lick – 26% crude protein.

[4] Conception: $\left(\frac{\text{cows pregnant}}{\text{cows mated}}\right) \times 100$
(does not include replacement heifers)

[5] Calf: $\left(\frac{\text{calves born}}{\text{cows in herd}}\right) \times 100$
(after replacement of non-pregnant cows with pregnant heifers, where possible, each year)

[6] Wean: $\left(\frac{\text{calves weaned}}{\text{cows in herd}}\right) \times 100$
(before replacement each year)

Table 4 reflects the effects of the licks, soils and years on certain weights as well as condition score at the end of the lick phase.

In 1985/86 the cows gained more weight ($P < 0.05$) during the lick phase than during the following three seasons. End mass did not differ from year to year ($P < 0.05$) but start mass was significantly lower ($P < 0.05$) in the 1985/86 season. Condition score at the end of the lick phase was lowest ($P < 0.05$) at the end of the 1988/89 season. During that year intake of especially RSL decreased markedly when compared to intake during the previous two seasons (Table 2).

Lick, *per se*, did not influence the start mass. Cows which received the RSL ended the lick phase in a better condition ($P < 0.05$) and with a higher mass ($P < 0.05$) than cows which received the DL. This is supported by higher ($P < 0.05$) weight gains by cows which received the RSL.

As could be expected, the Simmentaler cows were far heavier ($P < 0.01$) at the start and finish of the lick phase. Afrikaner cows gained more weight ($P > 0.05$) than Simmentaler cows on either lick. The Afrikaner cows also had a better final condition score ($P < 0.01$) than Simmentaler cows irrespective of lick. Table 4 also shows that Simmentaler and Afrikaner cows which received the RSL gained 15 and 9 kg more weight respectively than their counterparts which received the DL. The response to the lick was larger in the Afrikaner cows as they gained 60% of the weight of the Simmentaler cow, while ingesting only 43 to 52% of the RSL ingested by the Simmentalers.

Table 4 The mass and condition score of beef cows which received different licks while grazing summer *Cymbopogon–Themeda* veld (1986—1989)

	Main effects				Lick effects: DL				Lick effects: RSL			
Variable	SM[5] (kg)	EM[6] (kg)	Diff.[7] (kg)	Cond.[8]	SM (kg)	EM (kg)	Diff. (kg)	Cond.	SM (kg)	EM (kg)	Diff. (kg)	Cond.
Factor												
Year												
1985/86	464	514	50	3.36	460	508	48	3.31	469	520	51	3.41
1986/87	502	516	14	3.36	501	509	8	3.29	503	523	20	3.43
1987/88	491	522	31	3.35	491	513	22	3.30	490	530	40	3.41
1988/89	483	504	21	3.07	478	494	16	2.94	488	515	27	3.20
Signif.[1]	S	NS	S	S								
Breed[2]												
Sim	517	543	26	2.99	516	535	19	2.86	518	552	34	3.11
Afr	453	485	32	3.58	449	477	29	3.56	456	493	37	3.61
Signif.	HS	HS	NS	HS								
Soil[3]												
MS	489	518	29	3.36	484	510	26	3.28	494	525	31	3.44
ES	481	510	29	3.21	482	502	20	3.14	481	519	38	3.28
Signif.	NS	NS	NS	S	No significant interactions up to and including three-factor level.							
Lick[4]												
DL	483	506	24	3.21								
RSL	487	522	35	3.36								
Signif.	NS	S	S	S								

[1] Significance: NS = not significant ($P > 0.05$); S = significant ($P < 0.05$); HS = highly significant ($P < 0.01$); [2] Breed: Sim = Simmentaler, Afr = Afrikaner; [3] Soil: MS = meso/distrophic, ES = eutrophic; [4] Lick: DL = dicalcium phosphate salt lick, RSL = rumen-stimulating lick; [5] SM: Start mass of lick phase; [6] EM: End mass of lick phase; [7] Diff.: Mass change over lick phase; [8] Cond.: Condition score (scale 1—5): 1 = emaciated, 5 = very fat.

The effect of soil type on the performance of the cows was limited to condition score at the end of the lick phase. Cows on the MS were in a better ($P < 0.05$) condition than cows on the ES.

Table 5 presents the performance of the calves whose dams received the different licks. It is evident from the results reflected here, that the improved body mass and condition of the cows which received the RSL, was not carried over to their progeny. The results show that only breed had a statistically significant effect on any of the measured variables. The Afrikaner calves were in all respects smaller and lighter ($P < 0.01$) than the Simmentaler calves. What is of interest is the fact that the Afrikaner cow weaned 72% the calf mass of the Simmentaler cow. The Afrikaner cow, however, weighed 89% of the Simmentaler cow at weaning which indicates a slightly better efficiency in the Simmentaler cow. The Afrikaner cow used 43 to 57% less lick than the Simmentaler cow which indicates a lesser degree of dependance on supplementary feeding.

In a 100-cow unit with an average weaning percentage of 90%, Simmentaler and Afrikaner cows receiving the RSL would have to wean 21 and 11 kg heavier per calf respectively (at R2.75/kg) than cows receiving the DL, to enable them to recover the cost involved in supplying an RSL. Table 5 indicates that there was only a slight ($P < 0.05$) improvement in weaning mass.

Conclusions

Cows of both breeds reacted positively to the provision of an RSL as opposed to a DL in terms of mass gain ($P < 0.05$) and condition score ($P < 0.05$). The Afrikaner cows ended the lick phase in a better condition ($P < 0.01$) than Simmentaler cows, irrespective of lick. Neither breed was capable of transferring the positive effects experienced by the cows receiving the RSL to their progeny.

Cows on either soil type responded more positively to supplementation with an RSL compared to a DL. Cows on the MS tended to end the lick phase in a better condition ($P < 0.05$) than cows on the ES.

Year had a marked effect on lick intake, with intakes of both licks increasing with increased rainfall to the stage that rainfall became excessive (1988/89). The trial illustrated that guidelines for lick intakes should be adapted to take breeds into consideration as vast differences were observed between them. The Simmentaler cows always utilized both licks above recommended intake levels whereas Afrikaner cows rarely managed to utilize the lick at recommended levels.

Table 5 The mass of beef calves whose dams received different licks while grazing summer *Cymbopogon–Themeda* veld (1986—1989)

	Main effects				Lick effects: DL				Lick effects: RSL			
Variable	BM[5] (kg)	ADA[6] (kg)	WM[7] (kg)	CWM[8] (kg)	BM (kg)	ADA (kg)	WM (kg)	CWM (kg)	BM (kg)	ADA (kg)	WM (kg)	CWM (kg)
Factor												
Year												
1985/86	37	0.895	215	221	37	0.896	214	221	37	0.894	215	220
1986/87	36	0.894	222	220	37	0.902	224	222	36	0.886	219	218
1987/88	38	0.908	228	224	38	0.894	224	221	38	0.923	232	227
1988/89	36	0.831	215	206	36	0.823	212	205	36	0.839	218	208
Signif.[4]	NS	NS	NS	NS								
Breed[1]												
Sim	40	0.994	256	244	40	0.991	253	243	40	0.997	258	245
Afr	33	0.770	184	191	34	0.766	184	191	33	0.774	185	192
Signif.	HS	HS	HS	HS								
Soil[2]												
MS	37	0.879	219	217	37	0.871	216	215	37	0.887	222	219
ES	37	0.885	221	218	37	0.887	221	219	37	0.884	221	218
Signif.	NS	NS	NS	NS	No significant interaction up to and including three-factor level.							
Licks[3]												
DL	37	0.879	219	217								
RSL	37	0.885	221	218								
Signif.	NS	NS	NS	NS								

[1] Breed: Sim = Simmentaler, Afr = Afrikaner.

[2] Soil: MS = meso/distrophic, ES = eutrophic.

[3] Lick: DL = dicalcium phosphate salt lick, RSL = rumen-stimulating lick.

[4] Significance: NS = not significant ($P > 0.05$), HS = highly significant ($P < 0.01$).

[5] BM: Birth mass.

[6] ADA: Average daily gain on day of age.

[7] WM: Actual weaning mass; [8] CWM: 205-day corrected weaning mass.

Owing to the high intake (planned and realized) of the RSL as compared to the DL, cows receiving the RSL would have to perform considerably better than cows receiving the DL to cover expenses. This was not found in this trial. Conception was not affected by lick treatment. Despite the fact that cows receiving the RSL weaned slightly heavier ($P > 0.05$) calves, the difference was not sufficient to make this practice economically justifiable.

On well-managed veld in the western highveld where sufficient roughage of a good quality is available during the summer, the supplementation of beef breeder cows with an RSL during the latter part of the summer (from January) is not justified. The DL gave comparable results at much reduced costs.

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