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SUPPLEMENTING SHEEP WITH PROTEIN AND PHOSPHORUS ON NATIVE PASTURE OF THE CENTRAL ORANGE FREE STATE. 2. FEED INTAKE, MASS CHANGES AND WOOL PRODUCTION*

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(**Key words:** *Supplementation, protein, phosphorus, feed intake, mass changes, wool production)*
(**Sleutelwoorde:** *Aanvullende voeding, proteïen, fosfor, voerinname, massaveranderinge, wolproduksie)*

OPSOMMING: AANVULLING VAN PROTEÏEN EN FOSFOR AAN SKAPE OP NATUURLIKE WEIDING VAN DIE SENTRALE ORANJE-VRYSTAAT. 2. VOERINNAME, MASSAVERANDERINGE EN WOLPRODUKSIE

Die invloed van proteïen- en fosforaanvulling aan Dorper- en Merinohamels op veldweiding is oor 'n periode van een jaar ondersoek. Beide aanvullings is op 2 maniere voorsien naamlik as 'n lek óf as 'n daaglikse toediening via rumenkannules. Sommige van die waargenome verskille in vrywillige voerinname en liggaamsmassaveranderinge tussen die verskillende behandelings en rasse was betekenisvol ($P \leqslant 0,05$). Geen definitiewe tendens ten gunste van enige behandeling kon egter waargeneem word nie. Die Merino's het daagliks betekenisvol ($P \leqslant 0,05$) meer verteerbare organiese materiaal (47,4 g vs 43,1 g per $W_{kg}^{0,75}$) en ruproteïen (8,85 g vs 8,02 g per $W_{kg}^{0,75}$) as die Dorpers ingeneem. Die Dorpers het 'n betekenisvolle ($P \leqslant 0,05$) hoër groeitempo as die Merino's gehandhaaf. Geen statisties betekenisvolle ($P \leqslant 0,05$) verskille in wolproduksie kon by die Merino's tussen behandelings binne seisoene gevind word nie. Die Merino's het gedurende die somerperiode gemiddeld 60% meer wol produseer as gedurende die winterperiode. Die inname van verteerbare organiese materiaal en ruproteïen het 'n seisoenspatroon getoon waarin reënval 'n oorheersende rol gespeel het.

SUMMARY:

The influence of supplementary protein and phosphorus to Dorper and Merino wethers on native pasture was investigated over a period of one year. The supplements were provided by 2 different methods namely as a lick or at a constant daily level via rumen cannulae. Some of the observed differences in voluntary feed intake and body mass changes between the different treatments and breeds, were statistically significant ($P \leqslant 0,05$). However, no definite trend due to any of the treatments could be found. The Merinos consumed significantly ($P \leqslant 0,05$) more digestible organic matter (47,4 g vs 43,1 g per $W_{kg}^{0,75}$) and crude protein (8,85 g vs 8,02 g per $W_{kg}^{0,75}$) than the Dorpers. The Dorpers maintained a significantly ($P \leqslant 0,05$) higher rate of gain than the Merinos. No significant ($P \leqslant 0,05$) differences in wool production by the Merinos between treatments and within seasons, could be found. During the summer period the Merinos produced on average 60% more wool than during the winter period. Both intake of digestible organic matter and crude protein followed a seasonal trend in which rainfall played a dominant part.

The practice of supplementing grazing ruminants with various mineral and rumen stimulating supplements has become an integral part of livestock production in South Africa (Bisschop, 1964; Coetzee, 1969; Louw, 1978). According to Louw (1979) the total expenditure by South African farmers on supplements amounts to R20 million per annum. Scientific justification for this practice is to a large extent, based on principles established in conventional feed-intake and digestibility trials. These principles are applied to grazing animals on the asssumption that this type of extrapolation is justified.

The nutritive value of a feed depends largely on its chemical composition, digestibility of the ingested nutrients and the voluntary intake of the feed by the animal (Blaxter, 1964). Therefore, the nutritive value of a feed can be improved only by altering one or more of these factors to the advantage of the animal. In an effort to obtain more quantitative information on these aspects, De Waal, Engels & Van der Merwe (1980) studied the influence of protein and phosphorus supplementation on the grazing behaviour of sheep. They found that neither a protein nor a phosphorus supplement, either as a lick or administered directly into the rumen, influenced the grazing behaviour of sheep on native pasture as reflected in the crude protein content and organic matter digestibility of samples collected by oesophageally fistulated sheep.

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The current investigation was carried out in order to obtain more information on the influence of protein and phosphorus supplementation on voluntary feed intake, body mass changes and wool production of sheep grazing native pasture of the central Orange Free State.

Procedure

The experiment was conducted over a period of one year on native pasture at the Agricultural Research Institute, Glen. The pasture could be described as a *Themeda/ Cymbopogon* veld type (Acocks, 1953). *Themeda triandra, Eragrostis chloromelas* and *Cymbopogon plurinodis* were the dominant grasses, comprising 61,8% of the basal plant cover.

Two types of supplement were used, namely:

(i) a Protein supplement (Fish meal 50%, Salt 30%, Dicalciumphosphate 15% and Molasses meal 5%) and

(ii) a Salt/Phosphate supplement (Salt 50%, Dicalciumphosphate 45% and Molasses meal 5%).

Young Dorper and Merino wethers were used as experimental animals. At the onset of the study the Dorpers and Merinos were respectively 9 and 12 months old. The sporadic and inconsistent consumption of supplements by sheep is often offered as the cause for the poor response by sheep to supplementary feeding in the form of licks. The 2 supplements were therefore, administered by 2 different methods, namely:

(i) as a lick in Treatments 1 and 2 and

(ii) at a constant daily level via rumen cannulae in Treatments 3 and 4 (30,4 g Salt/Phosphate and 61,3 g Protein supplement respectively). Swart, Niemann, Engels & Biel (1971) found that 30 g fish meal per day was adequate to promote a positive animal response on *Themeda triandra* hay.

The experimental design (fully randomized) with the number of sheep per breed and per treatment is presented in Table 1.

Table 1

The experimental design indicating the number of sheep per breed and per treatment

Breed	Treatment Group 1: Salt/Phosphate supplement *ad lib.*	Group 2: Protein supplement *ad lib.*	Group 3: Salt/Phosphate supplement per RF	Group 4: Protein supplement per RF	Number of sheep per breed
Dorper	5 Intact (Control)	5 Intact	5 RF	5 RF	20
Merino	5 Intact (Control)	5 Intact	5 RF	5 RF	20
Dorper	3 OF (Control)	3 OF	3 OF & RF	3 OF & RF	12
Merino	3 OF (Control)	3 OF	3 OF & RF	3 OF & RF	12
Number of sheep per treatment	16	16	16	16	Total number of sheep = 64

OF – oesophageal fistulae
RF – rumen fistulae
Intact – no fistulae

A 3 camp rotational grazing system with a stocking rate of one sheep per hectare per annum was used. Due to practical considerations, the sheep in Treatments 1 and 2 were run as separate flocks, while those in Treatments 3 and 4 were run together as a third flock. The 3 flocks were rotated between the available camps on a weekly basis to eliminate any effects due to differences in basal plant cover. The experiment lasted from June 1977 to May 1978.

Three oesophageally fistulated (OF) sheep per treatment and per breed (Table 1) were used for the collection of samples from the pasture on a monthly basis as described by De Waal *et al.* (1980). Digestibility of organic matter (OM) of the native pasture was estimated according to the method described by Engels & Malan (1978). The crude protein content of the pasture was expressed on an ash-free (OM) basis.

The voluntary feed intake of 5 sheep per breed per treatment was determined on a monthly basis. Total excretion of faeces was collected over a 7 day period by means of faeces collection bags. The bags were designed in such a way that loss of faeces was virtually impossible. The intake of OM was then estimated by means of the following equation:

$$\underset{\text{(g/day)}}{\text{OM intake}} = \frac{100}{100 - \%\ \text{OM digestibility}} \times \frac{\text{Daily excretion of OM (g)}}{1}$$

The sheep were weighed at the beginning and end of each 7-day period of faeces collection – the average for each individual being taken as the body mass for that particular month. The sheep were not fasted prior to weighing, but were always weighed directly off the pasture between 07h00 and 09h00.

All the sheep were shorn during March 1977, before the trial commenced in June 1977, in order to eliminate any existing differences in wool production. The sheep were shorn again during November 1977 and also at the conclusion of the trial in June 1978. This was done in order to obtain an indication of any difference in rate of wool production between the winter and summer periods. The winter period extended from March 1977 to November 1977 (247 days) and the summer period from November 1977 to June 1978 (217 days). In the case of the Merinos, mid rib wool samples (± 300 g) were taken from each sheep for objective measurement of clean yield, staple length, crimp number per 25 mm and fibre diameter. The total fleece mass of each sheep was recorded after shearing.

The voluntary consumption of the 2 supplements by the sheep in Treatments 1 and 2 was recorded on a monthly basis. Daily lick intake per sheep was subsequently calculated for each specific month.

Results

The average daily digestible organic matter intake (DOMI)per $W_{kg}^{0,75}$ by the 2 breeds in the different treatments (Table 2) showed that, although some of the differences in DOMI between treatments within breeds were significant ($P \leqslant 0,05$), these differences were by no means consistent. However, significant ($P \leqslant 0,05$) breed differences regarding DOMI did exist within the 4 treatments. The Merinos consumed significantly ($P \leqslant 0,05$) more DOM per day than the Dorpers (47,4 g vs 43,1 g per $W_{kg}^{0,75}$).

A statistical analysis of the average daily intake of crude protein per $W_{kg}^{0,75}$ by the 2 breeds in the different treatments (Table 3) revealed that the crude protein intake of the Dorpers from the pasture was significantly ($P \leqslant 0,05$) influenced by treatment in 4 of the 12 months only. However, as indicated in Table 3, only some of these differences were significant, evincing no consistent pattern of response. In the case of the Merinos, significant ($P \leqslant 0,05$) differences between treatments occurred in 8 of the 12 months. Again the influence of treatment was not consistent.

The Merinos consumed on average significantly ($P \leqslant 0,05$) more protein per day than the Dorpers (8,85 g vs 8,02 g per $W_{kg}^{0,75}$ – Table 3). It is also clear from the results in Table 3 that the protein intake of both breeds followed a definite seasonal trend due to the influence of rainfall on plant growth. De Waal *et al.* (1980) clearly demonstrated the close relationship between rainfall and protein content of the native pasture.

The average daily intake of the supplements by the sheep in Treatments 1 and 2 for the different months of the experimental period, as well as the constant daily levels administered to the sheep in Treatments 3 and 4, are presented in Figure 1.

More specific detail regarding the intake of the different components of the supplements by the sheep, is presented in Table 4.

From Figure 1 and Table 4 it is evident that the highest average daily intake of the licks by the sheep in Treatments 1 and 2 occurred during August and July 1977, respectively. After these periods of peak consumption, the average daily lick intake exhibited a declining trend until the end of the trial. It is also interesting to note the large difference between the *ad lib.* consumption of the licks by the sheep in Treatments 1 and 2 in comparison with the constant daily doses administered via rumen cannulae to those in Treatments 3 and 4.

The average initial, monthly and final body mass of the 2 breeds in the different treatments are presented in Table 5.

Table 2

The average daily digestible organic matter intake (DOMI) by the 2 breeds in the respective treatments for the different months of the experimental period

Treatment	Breed	1977 June	July	Aug.	Sept.	Oct.	Nov.	1977 Dec.	1978 Jan.	Feb.	March	April	1978 May	Treatment average	± SE
		DOMI/$W^{0,75}$/day kg													
		g	g	g	g	g	g	g	g	g	g	g	g	g	
(1) Salt/Phosphate supplement *ad lib.*	D	34,4	40,5	$42,3^{a}$	55.0	$46,8^{a}$	44,1	$36,7^{a}$	50,4	$46,5^{a}$	45,3	34,9	30,5	42,3	± 1,147
	M	$32,2^{1}$	42,4	$54,5^{1}$	47,9	$55,5^{1,2}$	$50,6^{1,2}$	47,9	53,6	47,5	46,7	41,4	32,2	46,0	± 1,322
(2) Protein supplement *ad lib.*	D	32,9	35,9	$53,0^{b}$	48,9	$56,8^{b}$	43,5	$45,8^{b}$	54,5	$37,4^{b}$	41,6	35,7	34,1	43,3	± 1,152
	M	$29,6^{1}$	44,7	$67,5^{2}$	49,2	$55,3^{1,2}$	$47,0^{1}$	46,7	59,5	47,6	43,5	40,9	35,1	47,2	± 1,322
(3) Salt/Phosphate supplement per RF	D	35,4	35,2	$52,4^{b}$	53,1	$48,1^{a}$	43,3	$49,3^{b}$	52,6	$41,7^{ab}$	42,8	33,2	32,9	43,2	± 1,152
	M	$30,5^{1}$	39,0	$59,2^{1}$	52,3	$50,0^{1}$	$51,6^{1,2}$	53,1	52,9	44,7	49,1	34,8	37,4	46,2	± 1,322
(4) Protein supplement per RF	D	40,3	40,3	$53,7^{b}$	48,6	$47,3^{a}$	41,8	$44,0^{ab}$	55,0	$41,0^{ab}$	45,4	33,1	32,7	43,6	± 1,152
	M	$47,9^{2}$	46,0	$58,9^{1}$	52,3	$59,0^{2}$	$58,7^{2}$	51,7	55,0	48,4	46,7	36,0	39,8	50,0	± 1,322

D – Dorpers : Averages in a column with the same superscript (a, b) do not differ significantly ($P \leqslant 0,05$)
M – Merinos: Averages in a column with the same superscript (1,2) do not differ significantly ($P \leqslant 0,05$)
RF – Rumen fistulae
SE – Standard error of mean

Table 3

The average daily intake of crude protein by the 2 breeds in the respective treatments for the different months of the experimental period

Treatment	Breed	1977 June	July	Aug.	Sept.	Oct.	Nov.	1977 Dec.	1978 Jan.	Feb.	March	April	1978 May	Treatment average	± SE
		Crude protein intake/$W^{0,75}$/day kg													
		g	g	g	g	g	g	g	g	g	g	g	g	g	
(1) Salt/Phosphate supplement *ad lib.*	D	5.27	5.98	$8,36^{a}$	9,78	10.62	8,80	7,53	$10,53^{a}$	8,96	$9,94^{a}$	$6,67^{a}$	$7,27^{a}$	8,31	± 0,214
	M	5,69	$4,78^{1}$	$8,52^{1}$	$10,52^{1}$	$11,23^{1}$	9,62	8,17	$11,05^{1}$	$9,07^{1,2}$	9,74	$7,23^{1}$	$8,11^{1}$	8,64	± 0,243
(2) Protein supplement *ad lib.*	D	5,73	5,45	$10,29^{b}$	9,15	12,10	7,44	7,21	$12,23^{bc}$	8,68	$7,80^{b}$	$8,43^{b}$	$5,96^{ab}$	8,37	± 0,215
	M	5.01	$6,33^{2}$	$11,49^{2}$	$8,42^{2}$	$12.56^{1,2}$	9,37	8,56	$10,97^{1}$	$10,23^{1}$	9,41	$9,44^{2}$	$8,37^{1}$	9,18	± 0,243
(3) Salt/Phosphate supplement per RF	D	4,58	4,67	$9,23^{ab}$	9,69	11,11	7,51	6,67	$8,69^{b}$	7,60	$8,84^{ab}$	$5,86^{a}$	$5,06^{b}$	7,46	± 0,215
	M	5,92	$6,66^{2}$	$10,92^{2}$	$10,44^{1}$	$11,29^{1}$	9,77	8,12	$8,89^{2}$	$8,71^{2}$	9,74	$6,80^{1}$	$6,65^{2}$	8,66	± 0,243
(4) Protein supplement per RF	D	5,32	5,19	$10,30^{b}$	10,41	11,14	8,06	7,58	$9,97^{bc}$	7,89	$7,65^{b}$	$6,35^{a}$	$5,60^{b}$	7,60	± 0,215
	M	6,45	$5,50^{1,2}$	$10,88^{2}$	$9,30^{1,2}$	$13,18^{2}$	10.57	7,99	$10.26^{1,2}$	$9,09^{1,2}$	9,54	$7,31^{1}$	$7,16^{1}$	8,93	± 0,243

D – Dorpers: Averages in a column with the same superscript (a, b, c) do not differ significantly ($P \leqslant 0,05$)

M – Merinos: Averages in a column with the same superscript (1,2) do not differ significantly ($P \leqslant 0,05$)

RF – Rumen fistulae

SE – Standard error of mean

Table 4

The average daily intake of phosphorus (P), sodium chloride (NaCl) and crude protein (CP) by the sheep via the respective supplements

Average daily intake of supplements, P, NaCl and CP

Month		Treatment 1 Salt/Phosphate supplement *ad lib.*			Treatment 2 Protein supplement *ad lib.*			
		Supplement	P	NaCl	Supplement	P	NaCl	CP
		g	g	g	g	g	g	g
June	'77	10,2	0,86	5,10	21,2	0,94	6,36	6,03
July	'77	12,3	1,04	6,15	28,2	1,25	8,46	8,02
August	'77	14,6	1,23	7,30	24,6	1,09	7,38	7,00
September	'77	9,3	0,78	4,65	19,6	0,87	5,79	5,57
October	'77	7,7	0,65	3,85	12,6	0,56	3,78	3,58
November	'77	8,5	0,72	4,25	14,1	0,63	4,23	4,01
December	'77	8,8	0,74	4,40	12,7	0,57	3,81	3,61
January	'78	6,2	0,52	3,10	10,7	0,48	3,21	3,04
February	'78	7,0	0,59	3,50	10,4	0,46	3,12	2,96
March	'78	7,8	0,66	3,90	9,5	0,42	2,85	2,70
April	'78	6,8	0,57	3,40	9,1	0,40	2,73	2,59
May	'78	4,9	0,41	2,45	6,5	0,29	1,95	1,85

Period		Treatment 3 Salt/Phosphate supplement per RF			Treatment 4 Protein supplement per RF			
		Supplement	P	NaCl	Supplement	P	NaCl	CP
		g	g	g	g	g	g	g
June	'77							
to								
May	'78	30,4	2,57	15,2	61,3	2,73	18,4	17,4

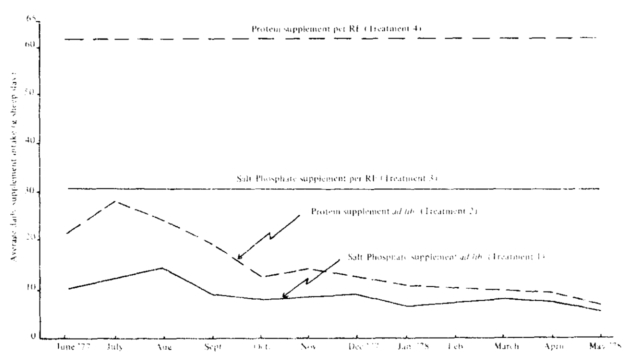

Fig. 1 *The average daily intake of supplements by the sheep for the different months of the experimental period*

The results in Table 5 indicate that the Dorpers in Treatments 1, 2 and 4 gained slightly in body mass from June to August 1977. Contrary to this the Dorpers in Treatment 3, as well as the Merinos in all the treatments, lost body mass over the same period. From August 1977 to April 1978 the sheep in all treatments gained in body mass. For the remainder of the trial (May 1978) the rate of gain reached a plateau and some of the groups even showed a slight decrease in body mass. Both the Dorpers and the Merinos in Treatment 3 gained considerably less (30 and 26% respectively) than their counterparts in the other 3 treatments.

With regard to total body mass gain over the experimental period, the Dorpers were superior to the Merinos. However, the differences between Dorpers and Merinos were significant ($P \leqslant 0,05$) for Treatments 1 and 4

Table 5

The average initial, monthly and final body mass of the sheep in the different treatments during the experimental period

Average body mass

Treatment	Breed	1977 1/6	June	July	Aug.	Sept.	Oct.	Nov.	1977 Dec.	1978 Jan.	Feb.	March	April	May	1978 5/6	Mass increase
		kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	%
(1) Salt/Phosphate supplement *ad lib.*	D	33,2	34,0	34,3	35,1	38,6	42,0	45,9	47,6	52,8	54,5	57,7	61,5	61,8	64,1	93,4
	M	29,7	29,9	28,8	28,9	31,3	34,6	35,6	39,2	40,9	43,5	46,0	48,6	47,4	49,9	68,3
(2) Protein supplement *ad lib.*	D	36,0	36,9	37,0	37,8	41,2	43,7	47,6	50,3	55,6	57,4	59,6	62,7	63,0	64,8	80,5
	M	34,0	33,2	32,5	32,3	35,1	39,0	40,7	43,4	46,2	47,9	50,9	53,3	53,5	54,7	61,2
(3) Salt/Phosphate supplement per RF	D	31,5	32,1	31,9	30,8	32,5	34,9	38,3	40,0	42,5	44,6	47,2	50,2	50,0	50,1	58,7
	M	33,9	33,4	32,9	32,3	33,2	37,2	38,2	40,0	43,6	44,6	46,8	50,2	49,0	49,0	45,6
(4) Protein supplement per RF	D	33,4	35,8	36,2	37,0	39,8	43,4	44,5	47,3	51,4	53,6	56,2	59,8	59,0	59,5	78,7
	M	29,5	30,8	30,4	30,6	32,7	35,7	37,2	39,0	41,8	44,2	44,6	48,3	46,9	45,8	55,9

D – Dorper
M – Merino
RF – Rumen fistulae

Table 6

The wool production of the Merino wethers in the different treatments during the winter and summer periods of the trial

Treatment	Season	Crude wool yield kg	Crude wool yield g/day	Clean yield %	Clean wool yield kg	Clean wool yield g/day	Staple length mm	Crimp number per 25 mm	Fibre diameter µ
(1) Salt/Phosphate supplement *ad lib.*	Winter*	2,540	10,28	74,40	1,886	7,64	50,8	10,62	19,06
	Summer**	3,580	16,50	73,36	2,628	12,11	96,4	7,54	22,82
(2) Protein supplement *ad lib.*	Winter	2,600	10,53	74,24	1,931	7,82	53,0	9,84	19,92
	Summer	3,770	17,37	73,70	2,778	12,80	94,0	6,68	24,44
(3) Salt/Phosphate supplement per RF	Winter	2,715	10,99	75,22	2,043	8,27	50,6	9,64	19,98
	Summer	3,680	16,96	74,80	2,750	12,67	98,8	7,28	22,82
(4) Protein supplement per RF	Winter	2,719	11,30	73,08	2,043	8,27	56,8	9,06	20,18
	Summer	3,890	17,93	75,84	2,951	13,60	94,6	7,36	23,96

* Winter – 247 day period (March 1977 to 3 November 1977)
**Summer – 217 day period (3 November 1977 to June 1978)

only. Differences within breeds were only significant ($P \leqslant 0{,}05$) between the Dorpers in Treatments 1 and 3.

A statistical analysis revealed that wool production (Table 6) was not influenced significantly ($P \leqslant 0{,}05$) by treatment within seasons. The differences between seasons within treatments were highly significant ($P \leqslant 0{,}01$). It can be calculated from the results in Table 6 that the average wool production of the Merinos during the summer period was 60% higher than during the winter period. This higher wool production may be ascribed to an increase in both fibre length and fibre diameter of 82,3 and 18,8% respectively.

Discussion

De Waal *et al.* (1980) concluded that differential supplementation of protein and phosphorus had little effect on the selective grazing behaviour of non-reproducing sheep as reflected by the crude protein content and digestibility of OM in samples collected by oesophageally fistulated (OF) sheep. However, the actual intake of digestible nutrients is of greater importance than diet composition. The real advantage of any economical supplementary feeding strategy must be reflected in animal response such as positive changes in body mass and wool growth. This kind of response can only be the result of an increase in feed intake from the pasture and/or a possible increase in the digestibility of the ingested feed (Nolan, Ball, Murray, Norton & Leng, 1974).

The significantly higher ($P \leqslant 0{,}05$) feed intake per $W_{kg}^{0,75}$ of the Merino in comparison with the Dorper found in this study, is in agreement with the results of Engels, Malan & Baard (1974). This finding is important with regard to decisions pertaining to stocking rate. However, in practice the adult Dorper is generally a larger animal than the Merino.

It is claimed that rumen stimulating supplements increase both feed intake and digestibility of low quality roughages (Van Niekerk & Van der Merwe, 1966; Swart *et al.*, 1971; Louw, 1978). The protein supplement provided to the sheep in Treatments 2 and 4 could be regarded as rumen stimulating. Unfortunately, it was not possible to measure the influence of supplementation on *in vivo* digestibility in the present study. The nutritional advantage of the protein supplement should have been reflected in body mass changes. This could only have been the result of an increase in digestible nutrient intake. This was not the case (Table 2). The contradiction between the results of the present study and those of Van Niekerk & Van der Merwe (1966), Swart *et al.* (1971) and Louw (1978) lies within the difference in experimental regimes. In contrast to the present study which was carried out with grazing sheep, the aforementioned authors used a variety of low quality roughages fed to penned sheep. Obviously, the inherent selective grazing behaviour of the sheep must have been limited in such cases, especially where the diet was offered in chopped or ground form.

The data in Table 4 indicate that the lick intake of the sheep in Treatments 1 and 2 was rather low in comparison with the constant daily levels of the supplements provided in Treatments 3 and 4. An explanation for this low voluntary lick intake could at this stage be no more than speculative. However, the sporadic and inconsistent level of intake of licks by grazing sheep has already been identified as a problem (Botha, 1962; Coetzee 1969; Nolan *et al.*, 1974; Langlands & Bowles, 1976). Therefore, it is doubtful whether supplementation at the levels recorded in the present investigation, could have any advantage in terms of increased animal production.

The maintenance energy requirement of sheep is estimated at 22 g DOM per $W_{kg}^{0,75}$ per day (ARC, 1965). However, Engels (1972) estimated the maintenance requirement of grazing sheep to be 33,5 g DOM per $W_{kg}^{0,75}$/day. This is in very good agreement with results reported by Young & Corbett (1968) for grazing sheep. Therefore, it appears that, with the exception of June 1977, April 1978 and May 1978, the sheep consumed sufficient DOM to allow for growth (Table 2). The results in Tables 2 and 5 show that the level of DOMI was reflected in body mass changes. The sharp increase in body mass observed between August and September 1977, was the result of the emergence of early spring growth. An increase in both crude protein content and digestibility of OM in OF-collected samples indicated that new spring growth had been ingested by the sheep since August 1977 (De Waal *et al.*, 1980). From September 1977 until April 1978 the sheep, in all treatments, gained live mass at a relatively high rate. During May 1978 live mass of the sheep tended to reach a plateau.

The results in Table 5 indicate that the sheep in Treatment 1 (Control) maintained the highest rate of gain followed by those in Treatments 2, 4 and 3 in that order. The rather poor growth rate of the sheep in Treatment 3 (both breeds) is difficult to explain. However, the possibility of an adverse effect of salt should not be overlooked. The sheep in Treatments 3 and 4 received 15,2 and 18,4 g NaCl per day respectively for about 1 year. In addition, the sheep in Treatment 4 received 17,4 g crude protein daily over the same period. The higher growth rate of the sheep in Treatment 4 (Table 5) points to the possibility that crude protein supplementation alleviated the detrimental effect of NaCl to some extent. These aspects are at present being investigated. With regard to body mass gain within treatments (Table 5), the Dorpers were superior to the Merinos. This is to be expected, the Dorper being considered a mutton breed in comparison with the predominantly wool producing Merino.

According to NRC (1975), the crude protein requirement of sheep for slow growth is estimated at 4,73 g per $W_{kg}^{0,75}$ per day. The results of this study indicate that, with the exception of June and July 1977, crude protein intake from the pasture appeared to be sufficient for moderate and even rapid growth. The crude protein intake of the Dorpers reached a peak of 250 g per day in January 1978. The corresponding figure of 195 g for the Merinos occurred in October 1977. In view of the protein intake from the pasture observed in this study, the contribution of the crude protein via the supplements (Treatments 2 and 4) becomes almost negligible.

It has been reported that an increase in wool production occurs when supplementing low quality roughages with NPN or protein (Coetzee, Lesch & Nel, 1967; Coetzee & Pieterse, 1967; Coetzee & Dyason, 1968; Coetzee & Lesch, 1969; Jacobsz & Kruger, 1970). However, in addition to the supplementary protein or NPN, the low quality roughages were almost invariably supplemented with energy in these studies (Coetzee & Dyason, 1968; Coetzee & Lesch, 1969). Wool production depends not only on energy and protein, but is also affected by some interaction between these two components (Black, Robards & Thomas, 1973), as well as the amount and composition of protein reaching the abomasum (Reis & Schinkel, 1964 as quoted by Colebrook, Ferguson, Hemsley, Hogan, Reis & Weston, 1968). The results of Robards & Pearce (1975) and Robards, Tribe & Thomas (1976) indicate that wool production is more dependent on DOMI than on dietary nitrogen level. However, this statement is based on the assumption that the crude protein of the diet is at an acceptable level for wool production. According to both Ferguson (1959) and Cloete (1969) wool production is dependent on mainly energy intake once protein content reaches a level of 7,0 to 7,5%.

In view of this finding, the lack of response in wool production to supplementary feeding was not altogether unexpected in the present study. The dietary crude protein content varied between 7,9% and 14,8% in the OF-collected samples (De Waal *et al.*, 1980). Furthermore, the results presented in Table 3 indicate that crude protein intake could hardly have been a limiting factor to wool production.

The results of the present study showed a pronounced difference (60%) in rate of wool production between the summer and the winter periods. The observed increase in wool production was brought about by an average increase of 82,3% in staple length and 18,8% in fibre diameter from the winter to the summer period. This is substantiated by the results of Irazoqui & Hill (1970) where they found that about 66% of the nutritionally induced variation in wool production was due to an alteration in fibre diameter and the remaining 34% to staple length.

Any input regarding supplementary feeding must be reflected in a higher output in terms of animal production. Furthermore, this increased output must be justified from an economic point of view. The results of the present study were rather disappointing in the sense that supplementary feeding at the levels applied, could not be reflected in animal production. In spite of this rather poor response to supplementary protein and phosphorus, the extrapolation of the results to grazing conditions differing widely from those of the present study, could lead to unrealistic recommendations. The present study clearly shows that more research on supplementary feeding, including various types of native pasture and with sheep differing in physiological status, needs to be done.

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