Supplementation of lactating Dorper and Merino ewes on *Themeda cymbopogon* veld. 2. Diet quality and feed intake

H.O. de Waal* and L.C. Biel[1]
Agricultural Research Institute, Private Bag X01, Glen 9360, Republic of South Africa

Received 14 April 1988; accepted 8 August 1989

Extract from Ph.D (Agric.) thesis submitted by HOdeW to the Department of Animal Science, University of Stellenbosch, 1986.

The effects of energy and crude protein (CP) supplementation on feed intake of lactating ewes grazing native pasture (veld) were studied during two autumn (1981 and 1982) and two spring (1983 and 1984) lambing seasons. The CP content of the diet selected by oesophageally fistulated sheep was higher in summer (1983: 10,8—13,3% and 1984: 14,9—19,8%) than in winter (1981: 5,9—8,3% and 1982: 6,7—8,7%). Digestibility of organic matter (OMD) of the diet was also higher in summer (1983: 58,5—64,0% and 1984: 56,6—65,6%) than in winter (1981: 54,2—58,8% and 1982: 52,4—56,4%). Different levels of energy and / or CP were provided daily via rumen fistulae to the ewes. Herbage intake of lactating Merino and Dorper ewes was not increased in response to CP during the winter (1981 and 1982), but decreased when energy was supplemented. Supplementation of energy plus CP increased herbage intake slightly. The Dorper ewes were 22% and 28% respectively heavier than the Merino ewes in 1981 and 1982. Despite similar amounts of herbage ingested by the two breeds (DOM intake; DOMI / day), lactating Merino ewes had a higher herbage intake per metabolic size (DOMI / $Wkg^{0,75}$ / day). In summer, herbage intake of lactating Dorper ewes was not increased by supplementary CP (1983), but decreased by supplementary energy (1983 and 1984). Herbage intake (DOMI / $Wkg^{0,75}$ / day) of lactating Dorper ewes was substantially higher in summer. Total intake (herbage plus supplements) by the lactating ewes corresponded with animal performance in the respective treatments and seasons.

Die invloed van aanvullende energie en ruproteïen (RP) op die voerinname van lakterende ooie vanaf veldweiding, is gedurende twee herfs- (1981 en 1982) en twee lentelamseisoene (1983 en 1984) ondersoek. Die RP-inhoud van die dieet wat deur slukdermgefistuleerde skape geselekteer is, was hoër gedurende die somer (1983: 10,8—13,3% en 1984: 14,9—19,8%) as gedurende die winter (1981: 5,9—8,3% en 1982: 6,7—8,7%). Die verteerbaarheid van organiese materiaal (OMV) van die dieet was ook in die somer hoër (1983: 58,5—64,0% en 1984: 56,6—65,6%) as in die winter (1981: 54,2—58,8% en 1982: 52,4—56,4%). Verskillende peile energie en / of RP is daagliks via rumenfistels aan die ooie verskaf. Weidinginname van lakterende Merino- en Dorperooie is nie gedurende die winter (1981 en 1982) deur aanvullende RP verhoog nie, maar is wel deur aanvullende energie verlaag en in 'n mate verhoog deur gesamentlike aanvulling van RP en energie. Gedurende 1981 en 1982 was die Dorper-ooie onderskeidelik 22% en 28% swaarder as die Merino-ooie. Ten spyte van vergelykbare weidinginnames (inname van VOM; VOMI / dag), het die Merino-ooie meer per metaboliese grootte (VOMI / $Wkg^{0,75}$ / dag) gevreet. In die somer is die weidinginname van lakterende Dorperooie ook nie deur aanvullende RP verhoog nie (1983), maar deur aanvullende energie verlaag (1983 en 1984). Weidinginname (VOMI / $Wkg^{0,75}$ / dag) van lakterende Dorperooie was aansienlik hoër gedurende die somermaande. Totale inname (weiding plus aanvullings) deur die lakterende ooie was in ooreenstemming met diereprestasie in die onderskeie behandelings en seisoene.

Keywords: Crude protein, energy, feed intake, native pasture (veld), reproducing sheep, supplementation

* To whom correspondence should be addressed
[1] Present address: Agricultural Research Station, Armoedsvlakte, Vryburg 8600, Republic of South Africa

Introduction

Sheep producers in the grassveld of the central Orange Free State lamb their ewes down in either the spring and / or the autumn. However, animal performance, as reflected in body mass loss of lactating ewes and growth rate of lambs, is invariably affected by nutritional problems associated with each lambing season (De Waal, 1986). Consequently, producers resort to a myriad of licks (supplementary feeding) in an effort to prevent a decline in feed intake and the adverse effects on animal performance.

An insufficient intake of digestible nutrients is the most important constraint on animal production from pastures. According to Minson (1982), the amount of herbage ingested by grazing ruminants depends on the availability of herbage acceptable to the animal, the physical and chemical composition of the herbage, and the nutrient requirements as well as the capacity of the animal to ingest herbage. The nutritive value of a pasture can therefore be improved only by altering these factors to the advantage of the grazing animals. Supplementary feeding can increase the nutrient intake of grazing animals (McClymont, 1956) and correct deficiencies of pastures for animal production (Read, Engels & Smith, 1986; De Waal, Baard & Engels, 1989a; 1989b). However, the responses are unpredictable and usually poorer than expected (McClymont, 1956; De Waal, Engels & Van der Merwe, 1980; De Waal, Engels, Van der Merwe & Biel, 1981; De Waal *et al.*, 1989a; 1989b; De Waal & Biel, 1989). This is not totally surprising. Earlier studies concerning the nutritive value of veld in South Africa were based on the chemical analysis of hand-cut herbage samples (Du Toit, Louw & Malan, 1940). These data, and other subsequent reports, gave rise to the misconception that herbage quality ingested by grazing ruminants is generally low and deficient in several nutrients and, therefore, supplementation is required to support reasonable levels of animal production (Louw, 1969; 1979). Together with results from conventional feed intake and digestibility trials, this theory was used to develop the basic principles of supplementary feeding strategies (Coetzee, 1969; Louw, 1969; 1978; 1979) for ruminants grazing vastly different veld types. Moreover, the diet of grazing animals may differ substantially in quality, quantity and pattern of intake from that of similar animals given herbage harvested from the same pasture. Consequently, there may be quantitative differences between these two dietary regimens in the rate and extent and, therefore, end products of digestive processes (Corbett & Pickering, 1983). The nutritive value of veld and its ability to support animal production, as well as the role of supplementary feeding in promoting animal production, should therefore be studied under realistic grazing conditions.

This study was aimed at obtaining more information on the nutritive value of the grassveld in the central Orange Free State and the effects of supplementation on feed intake of lactating Merino and Dorper ewes during an autumn and spring lambing season.

Procedure

The trials were conducted at the Agricultural Research Institute, Glen, and included two autumn (1981 and 1982) and two spring (1983 and 1984) lambing seasons. The general experimental designs, procedures, and supplementation levels have been described by De Waal & Biel (1989). Supplements were provided daily via rumen fistulae to lactating Merino and Dorper ewes.

Three oesophageally fistulated Merino wethers were run with the lactating ewes during each trial for the collection of samples on three successive days at three-week intervals. The extrusa was squeezed through four layers of cheese cloth and dried in a force draught oven at 50°C (Engels, De Waal, Biel & Malan, 1981). The *in vitro* digestibility of organic matter (OMD) of the extrusa was determined according to the two-stage technique of Tilley & Terry (1963), as modified by Engels & Van der Merwe (1967). The OMD of the veld was then estimated according to the procedure described by Engels *et al.* (1981). Crude protein (CP) content of samples was determined as described by De Waal *et al.* (1989a).

In all trials, feed intake of the ewes was determined with Cr_2O_3 as external indicator when the ewe flock was on average four weeks post partum (early lactation). In 1981, an additional determination of feed intake was carried out at nine weeks post partum (late lactation). Gelatin capsules, containing 1 g Cr_2O_3 each, were dosed twice daily for 12 days at 08h00 and 16h30 via rumen fistulae to the ewes. During the last five days, rectal faecal grab samples were taken from each ewe at the time of dosing, dried at 100°C in a force draught oven and ground to pass a 1-mm screen. Subsequently, 5 g of the 10 individual subsamples of each ewe were pooled. Samples were prepared for analysis of Cr by atomic absorption spectrophotometry according to the method described by Williams, David & Iismaa (1962). Faeces from sheep which were run with the experimental sheep, but received no Cr_2O_3, were used as standards (Engels & Malan, 1979). Feed intake was estimated by using the following equations:

$$\begin{matrix}\text{OM excreted} \\ (\text{g day}^{-1})\end{matrix} = \frac{\text{g } Cr_2O_3 \text{ dosed per day}}{\% \ Cr_2O_3 \text{ in faecal DM}} \times \frac{\% \text{ OM in faeces}}{1} \quad (1)$$

and then

$$\begin{matrix}\text{OMI} \\ (\text{g day}^{-1})\end{matrix} = \frac{100}{1} \times \frac{\text{OM excreted in faeces (g day}^{-1})}{100 - \% \text{ OMD of pasture}} \quad (2)$$

where OMI = organic matter (OM) intake.

OMD of the pasture, estimated from samples collected by oesophageally fistulated wethers during the same period, was used in Equation 2.

Faecal OM output from the supplements was estimated by assuming constant OM digestibilities of 60% and 80%, respectively, for the HPC 60 and maize (De Waal, 1986). By subtracting these values from the total daily OM excretion, the DOM intake (DOMI) by the lactating ewes from the pasture was estimated (Gibb & Treacher, 1978; Young, Newton & Orr, 1980) thus:

$$\begin{matrix}\text{DOMI} \\ (\text{g day}^{-1})\end{matrix} = \frac{\text{g OMI day}^{-1}}{1} \times \frac{\% \text{ OMD of the pasture}}{100} \quad (3)$$

where OMI (g day^{-1}) =

$$\frac{100}{1} \times \frac{\text{g OM (faeces)} - \text{g OM from supplements in faeces}}{100 - \% \text{ OMD of pasture}} \quad (4)$$

Crude protein intake (CPI) of the ewes was estimated from their daily OMI (Equation 2) and the CP content of the pasture.

Table 1 Crude protein (CP) and digestible organic matter (DOM) content of samples collected by oesophageally fistulated (OF) sheep during four trial periods

Sampling date	CP* % ± *SE*	DOM % ± *SE*
11 May 1981	8,1 ± 0,203	56,3 ± 0,282
22 May 1981	8,3 ± 0,300	58,4 ± 0,258
16 June 1981	7,0 ± 0,793	54,2 ± 0,584
1 July 1981	5,9 ± 0,509	55,2 ± 0,721
28 May 1982	6,7 ± 0,356	55,2 ± 0,361
15 June 1982	8,6 ± 0,231	56,4 ± 0,599
6 July 1982	8,7 ± 0,545	52,4 ± 2,450
28 September 1983	10,8 ± 0,581	58,5 ± 0,785
12 October 1983	13,3 ± 0,030	58,9 ± 0,695
25 October 1983	11,4 ± 0,943	58,8 ± 0,327
20 November 1983	12,6 ± 0,318	64,0 ± 0,814
25 September 1984	14,9 ± 0,205	56,6 ± 1,330
16 October 1984	19,8 ± 0,875	65,6 ± 2,545
30 October 1984	18,8 –	63,5 –
15 November 1984	15,7 ± 0,100	58,4 ± 4,405

* Crude protein content expressed on an OM basis.

Results

The CP and DOM content of samples collected by oesophageally fistulated sheep during the respective trial periods (1981—1984) are presented in Table 1.

Table 1 shows that the CP content of the veld was substantially higher in 1983 and 1984 (spring / summer) than in 1981 and 1982 (autumn / winter). Although the OMD also tended to be higher during 1983 and 1984, the differences were of a smaller magnitude than for the CP content.

Feed intake (DOMI and CPI) of the lactating ewes in the respective trial periods and treatment groups are presented in Tables 2 to 6.

In 1981 and 1982 (Tables 2—4), only some of the differences in DOMI (herbage) between the ewes in the respective treatments were significant ($P \leqslant 0{,}05$; Harvey, 1976). The differences in total DOMI (herbage plus supplements) between treatments were significant ($P \leqslant 0{,}05$) in more cases, owing to substantial contributions in nutrient supply made by some of the supplements (De Waal & Biel, 1989). In 1983 and 1984 (Tables 5 and 6), none of the differences in DOMI (herbage or herbage plus supplements) between the Dorper ewes in the respective treatments were significant ($P \leqslant 0{,}05$).

Table 2 Digestible OM intake (DOMI) and crude protein intake (CPI) of Merino and Dorper ewes during early lactation in 1981

		Intake from pasture			Intake from pasture plus supplements		
Breed	Treatment	DOMI g day $^{-1}$	DOMI per Wkg^{0,75} g day $^{-1}$	CPI g day $^{-1}$	DOMI g day $^{-1}$	DOMI per Wkg^{0,75} g day $^{-1}$	CPI g day $^{-1}$
Merino	E 0	821^{a}	46,17^{a}	117	821^{ab}	46,10^{ab}	117
	E 100	693^{a}	40,82^{a}	99	763^{a}	44,94^{a}	108
	E 200	764^{a}	45,21^{a}	109	905^{ab}	53,55^{ab}	128
	PE 0	831^{a}	47,40^{a}	119	854^{ab}	48,71^{ab}	151
	PE 100	881^{a}	50,49^{a}	126	974^{ab}	55,82^{ab}	168
	PE 200	838^{a}	48,71^{a}	120	1002^{b}	58,24^{b}	171
Dorper	E 0	818^{a}	43,69^{a}	117	818^{ab}	43,28^{a}	117
	E 100	781^{a}	38,60^{a}	112	851^{ab}	42,06^{a}	121
	E 200	716^{a}	38,11^{a}	102	857^{ab}	45,61^{a}	121
	PE 0	812^{a}	41,01^{a}	116	835^{ab}	42,17^{a}	148
	PE 100	701^{a}	35,00^{a}	100	794^{a}	39,64^{a}	142
	PE 200	865^{a}	41,98^{a}	124	1029^{b}	49,94^{a}	175

^{a,b} Within breeds, averages for DOMI in a column without the same superscript differ significantly ($P \leqslant 0{,}05$); *t* test (Harvey, 1976).

Table 3 Digestible OM intake (DOMI) and crude protein intake (CPI) of Merino and Dorper ewes during late lactation in 1981

		Intake from pasture			Intake from pasture plus supplements		
Breed	Treatment	DOMI g day $^{-1}$	DOMI per Wkg^{0,75} g day $^{-1}$	CPI g day $^{-1}$	DOMI g day $^{-1}$	DOMI per Wkg^{0,75} g day $^{-1}$	CPI g day $^{-1}$
Merino	E 0	573^{a}	35,79^{a}	68	573^{a}	35,72^{a}	68
	E 100	495^{a}	32,37^{a}	59	565^{a}	36,95^{a}	68
	E 200	644^{a}	40,33^{a}	76	785^{b}	49,16^{b}	95
	PE 0	602^{a}	37,33^{a}	71	625^{a}	38,76^{ac}	103
	PE 100	633^{a}	37,73^{a}	75	726^{ab}	43,27^{ab}	117
	PE 200	620^{a}	37,33^{a}	73	784^{b}	47,20^{bc}	124
Dorper	E 0	610^{ab}	38,36^{a}	72	610^{a}	37,96^{ab}	72
	E 100	577^{ab}	33,06^{ab}	68	647^{a}	37,07^{a}	77
	E 200	452^{b}	26,96^{b}	54	593^{a}	35,37^{a}	73
	PE 0	547^{ab}	31,86^{ab}	65	570^{a}	33,20^{a}	97
	PE 100	533^{b}	28,89^{ab}	63	626^{a}	33,93^{a}	105
	PE 200	690^{a}	37,14^{a}	82	854^{b}	45,97^{b}	133

^{a,b,c} Within breeds, averages for DOMI in a column without the same superscript differ significantly ($P \leqslant 0{,}05$); *t* test (Harvey, 1976).

Table 4 Digestible OM intake (DOMI) and crude protein intake (CPI) of Merino and Dorper ewes during early lactation in 1982

		Intake from pasture			Intake from pasture plus supplements		
Breed	Treatment	DOMI g day $^{-1}$	DOMI per $Wkg^{0,75}$ g day $^{-1}$	CPI g day $^{-1}$	DOMI g day $^{-1}$	DOMI per $Wkg^{0,75}$ g day $^{-1}$	CPI g day $^{-1}$
Merino	E 0	813^{ab}	$51,74^{a}$	124	813^{a}	$51,84^{a}$	124
	E 100	722^{ab}	$47,47^{ab}$	110	792^{a}	$52,07^{a}$	119
	E 200	620^{b}	$39,87^{b}$	95	761^{a}	$48,94^{a}$	114
	PE 0	802^{ab}	$48,36^{ab}$	123	825^{a}	$49,75^{a}$	115
	PE 100	830^{a}	$52,99^{a}$	127	923^{a}	$58,93^{a}$	169
	PE 200	706^{ab}	$44,06^{ab}$	108	870^{a}	$54,29^{a}$	159
Dorper	E 0	703^{ab}	$40,27^{a}$	107	703^{a}	$40,27^{a}$	107
	E 100	655^{a}	$36,04^{a}$	100	725^{a}	$39,89^{a}$	109
	E 200	713^{ab}	$40,87^{a}$	109	854^{ab}	$48,95^{ab}$	128
	PE 0	741^{ab}	$38,04^{a}$	113	764^{a}	$39,22^{a}$	145
	PE 100	855^{b}	$46,42^{a}$	131	948^{b}	$51,47^{b}$	173
	PE 200	784^{ab}	$40,74^{a}$	120	948^{b}	$49,26^{ab}$	171

[a,b] Within breeds, averages for DOMI in a column without the same superscript differ significantly ($P \leq 0,05$); *t* test (Harvey, 1976).

Table 5 Digestible OM intake (DOMI) and crude protein intake (CPI) of Dorper ewes during early lactation in 1983

	Intake from pasture			Intake from pasture plus supplements		
Treatment	DOMI g day $^{-1}$	DOMI per $Wkg^{0,75}$ g day $^{-1}$	CPI g day $^{-1}$	DOMI g day $^{-1}$	DOMI per $Wkg^{0,75}$ g day $^{-1}$	CPI g day $^{-1}$
E 0	958^{a}	$60,31^{a}$	186	958^{a}	$60,25^{a}$	186
E 100	720^{a}	$46,34^{a}$	140	790^{a}	$50,85^{a}$	149
E 200	865^{a}	$51,55^{a}$	168	1006^{a}	$59,95^{a}$	187
PE 0	1062^{a}	$62,70^{a}$	207	1085^{a}	$64,06^{a}$	239
PE 100	856^{a}	$52,19^{a}$	167	949^{a}	$57,86^{a}$	209
PE 200	863^{a}	$50,56^{a}$	168	1027^{a}	$60,17^{a}$	219

[a] Within breeds, averages for DOMI in a column without the same superscript differ significantly ($P \leq 0,05$); *t* test (Harvey, 1976).

Table 6 Digestible OM intake (DOMI) and crude protein intake (CPI) of Dorper ewes during early lactation in 1984

	Intake from pasture			Intake from pasture plus supplements		
Treatment	DOMI g day $^{-1}$	DOMI per $Wkg^{0,75}$ g day $^{-1}$	CPI g day $^{-1}$	DOMI g day $^{-1}$	DOMI per $Wkg^{0,75}$ g day $^{-1}$	CPI g day $^{-1}$
E 0	1762^{a}	$100,25^{a}$	527	1762^{a}	$100,34^{a}$	527
E 150	1450^{a}	$85,23^{a}$	433	1556^{a}	$91,46^{a}$	444
E 300	1571^{a}	$87,19^{a}$	470	1784^{a}	$99,01^{a}$	491
E 450	1470^{a}	$82,57^{a}$	439	1789^{a}	$100,49^{a}$	471

[a] Within breeds, averages for DOMI in a column without the same superscript differ significantly ($P \leq 0,05$); *t* test (Harvey, 1976).

Differences in herbage intake (DOMI day^{-1}) between breeds in the corresponding treatments during 1981 and 1982 (Tables 2—4), were relatively small. The Dorper ewes were heavier than the Merino ewes (De Waal & Biel, 1989), therefore the Merino ewes consumed more herbage per metabolic size (DOMI / $Wkg^{0,75}$). Feed intake of the Merino and Dorper ewes during early lactation in 1981, was *ca.* 10 g / $Wkg^{0,75}$ higher than in late lactation (Tables 2 & 3), which suggests a declining trend in feed intake with advancement of lactation.

In 1981 and 1982 (Tables 2—4), supplementary CP (PE 0, PE 100 and PE 200) tended to increase herbage intake. Furthermore, ewes receiving 100 g maize day^{-1} (E 100 and PE 100) tended to consume less herbage / Wkg^{0,75}, indicating some degree of substitution. In the case of those receiving 200 g maize day^{-1} (E 200 and PE 200), this phenomenon was not as apparent. The effect of supplementation on feed intake during 1981 and 1982 (Tables 2—4), was mainly reflected in a higher total DOMI / Wkg^{0,75} (herbage plus supplements) at the higher level of maize supplementation (E 200 and PE 200) and to a lesser extent also the lower level of maize supplementation (E 100 and PE 100).

Feed intake of the Dorper ewes in 1983 (Table 5) and 1984 (Table 6), was higher than in 1981 (Table 2) and 1982 (Table 4). Since the trials in 1983 and 1984 were conducted with less mature Dorper ewes (De Waal & Biel, 1989), these differences became more apparent by expressing feed intake in terms of Wkg^{0,75}. The exceptionally high DOMI and CPI of the Dorper ewes in 1984 (Table 6) was a result of the high CP content and digestibility of the pasture (Table 1), as well as an abundance of available pasture. This was also positively reflected in animal performance (De Waal & Biel, 1989).

There was a tendency, though non-significant ($P \leqslant 0,05$), in 1983 (Table 5) for Dorper ewes to consume less herbage in response to supplementary energy (E 100, E 200, PE 100 and PE 200). Since total DOMI of the ewes (herbage plus supplements) was with one exception (E 100) comparable, this also indicated a substitution effect. Supplementation of CP only (PE 0 *vs.* E 0) increased herbage intake slightly. With one exception during 1984 (E 150; Table 6), a substitution effect on herbage intake in response to supplementary energy was also apparent.

The CPI from the pasture was higher during 1983 (Table 5) and 1984 (Table 6) than in 1981 (Table 2) and 1982 (Table 4). The contributions made by the respective supplements to the CPI of the ewes varied considerably. The effect of the high CP content of certain supplements (De Waal & Biel, 1989; PE 0, PE 100 and PE 200), is reflected in the estimated total CPI (herbage plus supplements) of the ewes, especially during 1981 and 1982. In 1983 (Table 5) the supplements contributed less towards the CPI of the ewes.

Discussion

The CP and DOM content of the veld, as selected by oesophageally fistulated sheep during the four trials (Table 1), are in agreement with results from other studies conducted at Glen (Engels, Van Schalkwyk & Hugo, 1969; Engels, Van Schalkwyk, Malan & Baard, 1971; Engels, Baard & Malan, 1974a; Engels & Malan, 1978; De Waal *et al.*, 1980). Considering the quality of the diet, especially in 1983 and 1984 (spring / summer), a relatively high voluntary intake by the ewes was expected. This was reflected in the DOMI of the ewes (Tables 5 and 6). Even during the trials in 1981 and 1982 (autumn / winter), the quality of the diet (CP and DOM) was such that, provided intake was not impaired, it could sustain reasonable levels of animal production. However, when the herbage preferred by grazing sheep is limited, the overriding selective grazing behaviour may cause a sharp drop in intake, because the sheep spend most of their grazing time searching for acceptable plants and even parts of plants. Engels & Malan (1978) found that the intake of Merino wethers on veld was at times insufficient to meet maintenance requirements, even though the quality of the diet appeared to be satisfactory. Similar observations were made with SA Mutton Merino ewes (Engels & Malan, 1979) and young Merino and Dorper wethers (De Waal *et al.*, 1981). However, based solely on quality of selected herbage (Table 1), it seems that the lactating ewes and their lambs were better able to satisfy their nutrient requirements from veld during spring/summer (1983 and 1984).

Feed intake of lactating ewes is at a maximum four to six weeks post partum (Hadjipieris & Holmes, 1966; Peart, 1967; 1968). Therefore it was assumed that a response in feed intake to supplementation, would be greatest during this period. De Waal (1986) has estimated that lactating ewes at pasture require at least 55 g DOM/Wkg^{0,75} day^{-1}. In 1981 and 1982 (Tables 2 and 4), herbage intake by the ewes was less than the estimated minimum daily requirement. Total DOMI (herbage plus supplements) of the Merino ewes in some treatments (1981: E 100, PE 100 and PE 200; 1982: PE 100 and PE 200) was, however, owing to substantial contributions made by the supplements, higher than the estimated minimum requirement, while the total DOMI of the Dorper ewes was always less. The highest level of supplementation (De Waal & Biel, 1989; PE 200) contributed about 18% and 30% of the total DOMI and CPI, respectively, of the Merino and Dorper ewes during early lactation in 1981 and 1982. Despite this, all the lactating ewes lost body mass in 1981 and 1982 (De Waal & Biel, 1989).

Although the trials in 1983 and 1984 were conducted with Dorpers only, some conclusions on the differences in seasonal herbage intake may be drawn (Tables 2—6). During early lactation in 1981 (Table 2) and in 1982 (Table 4), the DOMI of Dorper ewes was very similar. This was in sharp contrast to the higher intake by Dorper ewes in 1983 and 1984 (Tables 5 & 6), presumably due to a substitution effect on herbage intake (McClymont, 1956; Allden & Jennings, 1962; Holder, 1962; Owen & Ingleton, 1963; Langlands, 1969; Milne, Maxwell & Souter, 1981), as a result of supplementation with maize. Similar trends, although at much lower levels of substitution, were also noted in 1981 and 1982 (Tables 2—4). Furthermore, the Dorper ewes in the Control groups (E 0; Tables 5 and 6), especially in 1984, consumed more herbage than their estimated minimum daily requirements. Moreover, the higher DOMI of the ewes during the trials in the spring/summer (1983 and 1984) was positively reflected in an overall higher level of animal performance (De Waal & Biel, 1989).

Nutrients derived from ingested feed and body tissue mobilization by lactating ewes are utilized for milk synthesis. From data published by Brett, Corbett &

Inskip (1972), Corbett (1968) and the Agricultural Research Council (1980), it was calculated that, during weeks 4 and 5 of lactation, a loss of 100 g day^{-1} by ewes can potentially yield 440 g milk. Furthermore, from published data (Brett *et al.*, 1972; Engels & Malan, 1975; Robinson, 1977; Agricultural Research Council, 1980; Bass, Fishwick & Parkins, 1980; Corbett, 1968), it was calculated that a feed intake of 250, 500 and 750 g DOM is required to sustain daily milk yields of 500, 1000 and 1500 g, respectively. This is in agreement with estimates by Coop & Drew (1963) and Hadjipieris & Holmes (1966), showing that lactating ewes require about 0,5 g DOM per g milk produced. The extent and rate of body tissue mobilization during lactation have a sparing effect on the feed intake required for milk synthesis *per se* and, conversely, the level of feed intake has an effect on the rate and extent of body tissue mobilization (Cowan, Robinson, McDonald & Smart, 1980). It was calculated from the results of De Waal & Biel (1989) that the rate of body mass loss by the ewes in 1981 and 1982 varied respectively between 50 to 100 and 115 to 160 g day^{-1} for the Merino ewes and between 100 to 200 and 175 to 270 g day^{-1} for the Dorper ewes. In view of the inadequate nutrient intake by the lactating ewes in 1981 and 1982 (Tables 2—4), the excessive and continuous losses in body mass by the ewes during lactation (De Waal & Biel, 1989) are therefore not surprising. In 1981 and 1982, combined supplementation of energy and CP (PE 100 and PE 200) at fairly high levels, could only reduce the rate of body mass loss by 50% (De Waal & Biel, 1989). However, a totally different situation prevailed during the spring / summer. In 1983 the Dorper ewes lost body mass until about the sixth week of lactation, whereafter they started regaining body mass and in 1984 the ewes started regaining mass after the third week of lactation (De Waal, 1986). This can be attributed to the greater availability of herbage with a higher quality (Table 1), which improved conditions for a higher digestible nutrient intake by the ewes and their lambs. This in turn increased milk yields by the ewes and therefore growth rates by the lambs (De Waal & Biel, 1989).

When feed intake was estimated during early lactation in 1981 and 1982, the Dorper ewes were, respectively, 22% (45 *vs.* 55 kg) and 28% (40,5 *vs.* 51,9 kg) heavier than the Merinos (De Waal, 1986). Thus, despite similar amounts of herbage ingested (g DOMI day^{-1}) by the two breeds (Tables 2 and 4), Merino ewes consumed more herbage per metabolic size (g DOMI / $Wkg^{0,75}$ day^{-1}). This difference in feed intake per metabolic size between the breeds is in agreement with other reports (Engels, Malan & Baard, 1974b; De Waal *et al.*, 1981). Moreover, this poses an interesting question regarding the voluntary daily herbage intake by lactating ewes from veld in winter. According to De Waal (1986), herbage was abundantly available during the trials in winter (1981 and 1982), yet the lactating ewes seemed incapable of increasing their daily herbage intake beyond a certain limit. When acceptable herbage is scarcely distributed, sheep can extend their grazing time in order to increase intake, but only to a limited extent (Allden & Whittaker, 1970). Despite claims that so-called 'rumen stimulating' supplements increase both feed intake and digestibility of low quality roughages (Van Niekerk & Van der Merwe, 1966; Swart, Niemann, Engels & Biel, 1971; Louw, 1978), the lactating ewes failed to consume more herbage in response to CP supplementation (PE 0, PE 100 and PE 200). Since these supplements may all be regarded as rumen stimulating, this is in agreement with the results of De Waal *et al.* (1981). Apparently, rumen activity, as influenced by the herbage ingested in these studies, was not suboptimal and could therefore not have been influenced by supplementary CP. Alternatively, the selective grazing behaviour of sheep, being a time-consuming process, simply prohibited any positive response.

It was not possible to measure the effect of supplementation on *in vivo* digestibility in the present study or the study by De Waal *et al.* (1981). However, any nutritional advantage of CP supplementation should have been reflected in positive responses in animal performance, which was not the case in either studies (De Waal *et al.*, 1981; De Waal & Biel, 1989). Results concerning the DM disappearance rate in the rumen, as determined with the fibre bag technique (De Waal, 1986), are particularly relevant. They showed that CP supplementation tended to increase the rate at which herbage was fermented *in sacco* in the rumen of the lactating ewes during winter by 22% (26,0% *vs.* 31,8% of DM disappeared / 24 h), in comparison to 3,9% in summer (49,0% *vs.* 50,9% of DM disappeared / 24 h). Part of the slower rate of DM disappearance in winter could have been a result of suboptimal rumen NH_3 concentrations. The relative resistance to microbial breakdown, resulting from senescent herbage during winter, seems to have been the primary factor limiting the rate of fermentation (De Waal, 1986). The small positive response in animal performance to supplementary CP and energy (PE 100 and PE 200) in winter (1981 and 1982) may therefore be ascribed mainly to the direct effects of an increase in nutrients available for absorption in the lower alimentary tract and to a lesser effect of rumen stimulation *per se* (De Waal, 1986).

Acknowledgements

The authors are indebted to Dr E.A.N. Engels, Mrs Heila Terblanche, Dr Marion Read, Miss Maksie Baard and the late Dr Daan Els for valuable assistance rendered during the course of the trial.

References

AGRICULTURAL RESEARCH COUNCIL, 1980. The nutrient requirements of ruminant livestock. Commonwealth Agricultural Bureaux. Farnham Royal, UK.

ALLDEN, W.G. & JENNINGS, A.C., 1962. Dietary supplements to sheep grazing mature herbage in relation to herbage intake. *Proc. Aust. Soc. Anim. Prod.* 4, 145.

ALLDEN, W.G. & WHITTAKER, I.A. McD., 1970. The determinants of herbage intake by grazing sheep: The interrelationships of factors influencing herbage intake and availability. *Aust. J. agric. Res.* 21, 755.

BASS, JEAN M., FISHWICK, G. & PARKINS, J.J., 1980. Soya bean meal, crystalline urea and a urea, mineral and vitamin solution as nitrogen sources for lactating ewes given whole oats. *Anim. Prod.* 31, 299.

BRETT, D.J., CORBETT, J.L. & INSKIP, M.W., 1972. Estimation of the energy value of ewe milk. *Proc. Aust. Soc. Anim. Prod.* 9, 286.

COETZEE, C.G., 1969. Proteïenaanvulling op hoë en lae voedingspeile. *Handl. S.-Afr. Ver. Diereprod.* 8, 43.

COOP, I.E. & DREW, K.R., 1963. Maintenance and lactation requirements of grazing sheep. *Proc. N. Z. Soc. Anim. Prod.* 23, 53.

CORBETT, J.L., 1968. Variation in the yield and composition of milk of grazing Merino ewes. *Aust. J. agric. Res.* 19, 283.

CORBETT, J.L. & PICKERING, F.S., 1983. Estimation of daily flows of digesta in grazing sheep. *Aust. J. agric. Res.* 34, 193.

COWAN, R.T., ROBINSON, J.J., McDONALD, I. & SMART, R., 1980. Effects of body fatness at lambing and diet in lactation on body tissue loss, feed intake and milk yield of ewes in early lactation. *J. agric. Sci., Camb.* 95, 497.

DE WAAL, H.O., 1986. Die voedingswaarde van veldweiding van die sentrale Oranje-Vrystaat vir lakterende skape met spesiale verwysing na die rol van aanvullende energie en ruproteïen. Ph.D (Agric.)-proefskrif, Universiteit van Stellenbosch.

DE WAAL, H.O., BAARD, MARGARIETHA A. & ENGELS, E.A.N., 1989a. Effects of sodium chloride on sheep. 1. Diet composition, body mass changes and wool production of young Merino wethers grazing native pasture. *S. Afr. J. Anim. Sci.* 19, 27.

DE WAAL, H.O., BAARD, MARGARIETHA A. & ENGELS, E.A.N., 1989b. Effects of sodium chloride on sheep. 2. Voluntary feed intake and changes in certain rumen parameters of young Merino wethers grazing native pasture. *S. Afr. J. Anim. Sci.* 19, 34.

DE WAAL, H.O. & BIEL, L.C., 1989. Supplementation of lactating Dorper and Merino ewes on *Themeda cymbopogon* veld. 1. Body mass changes of ewes and their lambs. *S. Afr. J. Anim. Sci.* 19, 141.

DE WAAL, H.O., ENGELS, E.A.N. & VAN DER MERWE, F.J., 1980. Supplementing sheep with protein and phosphorus on native pasture of the central Orange Free State. 1. Diet composition, digestibility and rumen ammonia concentration. *S. Afr. J. Anim. Sci.* 10, 203.

DE WAAL, H.O., ENGELS, E.A.N., VAN DER MERWE, F.J. & BIEL, L.C., 1981. Supplementing sheep with protein and phosphorus on native pasture of the central Orange Free State. 2. Feed intake, mass changes and wool production. *S. Afr. J. Anim. Sci.* 11, 217.

DU TOIT, P.J., LOUW, J.G. & MALAN, A.I., 1940. A study of the mineral content and feeding value of natural pasture in the Union of South Africa. *Onderstepoort J. Vet. Sci.* 14, 123.

ENGELS, E.A.N., BAARD, MARGARIETHA A. & MALAN, A., 1974a. Estimation of forage intake on pasture using faecal nitrogen concentration and *in vitro* digestibility results. *Agroanimalia* 6, 81.

ENGELS, E.A.N., DE WAAL, H.O., BIEL, L.C. & MALAN, A., 1981. Practical implications of the effect of drying and treatment on nitrogen content and *in vitro* digestibility of samples collected by oesophageally fistulated animals. *S. Afr. J. Anim. Sci.* 11, 247.

ENGELS, E.A.N. & MALAN, A., 1975. The energy intake and excretion of sheep grazing oat pasture. *Agroanimalia* 7, 81.

ENGELS, E.A.N. & MALAN, A., 1978. Die invloed van twee veebeladings op die samestelling van die dieet en inname van skape in 'n driekampstelsel in die sentrale Oranje-Vrystaat. *S.-Afr. Tydskr. Veek.* 8, 19.

ENGELS, E.A.N. & MALAN, A., 1979. Feed intake of non-pregnant, pregnant and lactating ewes on native pasture and lucerne hay. *S. Afr. J. Anim. Sci.* 9, 27.

ENGELS, E.A.N., MALAN, A. & BAARD, MARGARIETHA A., 1974b. The voluntary feed intake of three breeds of sheep on natural pasture. *S. Afr. J. Anim. Sci.* 4, 27.

ENGELS, E.A.N. & VAN DER MERWE, F.J., 1967. Application of an *in vitro* technique to South African forages with special reference to the effect of certain factors on the results. *S. Afr. J. Agric. Sci.* 10, 983.

ENGELS, E.A.N., VAN SCHALKWYK, A. & HUGO, J.M., 1969. The determination of the nutritive value potential of natural pastures by means of an oesophageal fistula and faecal indicator technique. *Agroanimalia* 1, 119.

ENGELS, E.A.N., VAN SCHALKWYK, A., MALAN, A. & BAARD, MARGARIETHA A., 1971. The chemical composition and *in vitro* digestibility of forage samples selected by oesophageally fistulated sheep on natural pasture of the central Orange Free State. *S. Afr. J. Anim. Sci.* 1, 43.

GIBB, M.J. & TREACHER, T.T., 1978. The effect of herbage allowance on herbage intake and performance of ewes and their twin lambs grazing perennial rye grass. *J. agric. Sci., Camb.* 90, 139.

HADJIPIERIS, G. & HOLMES, W., 1966. Studies on feed intake and feed utilization by sheep. I. The voluntary feed intake of dry, pregnant and lactating ewes. *J. Agric. Sci.* 66, 217.

HARVEY, W.R., 1976. Least-squares and maximum likelihood general purpose program. (252 K Mixed Model Version). Rev. edn. Ohio State University.

HOLDER, J.M., 1962. Supplementary feeding of grazing sheep – its effect on pasture intake. *Proc. Aust. Soc. Anim. Prod.* 4, 154.

LANGLANDS, J.P., 1969. The feed intake of sheep supplemented with varying quantities of wheat while grazing pastures differing in herbage availability. *Aust. J. agric. Res.* 20, 919.

LOUW, G.N., 1969. The nutritive value of natural grazings in South Africa. *Proc. S. Afr. Soc. Anim. Prod.* 8, 57.

LOUW, G.N., 1978. Die aanwending van voedselhulpbronne vir diereproduksie. *S.-Afr. Tydskr. Veek.* 8, 79.

LOUW, G.N., 1979. An evaluation of the application of stock licks in South Africa. *S. Afr. J. Anim. Sci.* 9, 133.

McCLYMONT, G.L., 1956. Response of stock to supplementary feeding on pastures. *Proc. Aust. Soc. Anim. Prod.* 1, 63.

MILNE, J.A., MAXWELL, T.J. & SOUTER, W., 1981. Effect of supplementary feeding and herbage mass on the intake and performance of grazing ewes early in lactation. *Anim. Prod.* 32, 185.

MINSON, D.J., 1982. Effects of chemical and physical composition of herbage eaten upon intake. In: Nutritional limits to animal production from pastures. Ed. Hacker, J.B., CAB, Farnham Royal, UK. p. 167.

OWEN, J.B. & INGLETON, JEAN W., 1963. A study of food intake and production in grazing ewes. II. The interrelationships between food intake and productive output. *J. Agric. Sci.* 61, 329.

PEART, J.N., 1967. The effect of different levels of nutrition during late pregnancy on the subsequent milk production of Blackface ewes and on the growth of their lambs. *J. agric. Sci., Camb.* 68, 365.

PEART, J.N., 1968. Lactation studies with Blackface ewes and their lambs. *J. agric. Sci., Camb.* 70, 87.

READ, MARION V.P., ENGELS, E.A.N. & SMITH, W.A., 1986. Phosphorus and the grazing ruminant. 2. The effects of supplementary P on cattle at Glen and Armoedsvlakte. *S. Afr. J. Anim. Sci.* 16, 7.

ROBINSON, J.J., 1977. Response of the lactating ewe to variation in energy and protein intake. In: EAAP 28th A. Study Meet., Brussels, S12, pp. 1–11.

SWART, J.A., NIEMANN, P.J., ENGELS, E.A.N. & BIEL, L.C., 1971. The influence of fish meal and yellow maize on the nutritive value of *Themeda triandra* for Merino sheep. *S. Afr. J. Anim. Sci.* 1, 25.

TILLEY, J.M.A. & TERRY, R.A., 1963. A two-stage technique for the *in vitro* digestion of forage crops. *J. Br. Grassl. Soc.* 18, 104.

VAN NIEKERK, A.I. & VAN DER MERWE, F.J., 1966. Some aspects of the nitrogen metabolism of sheep with special reference to the rumen. *Proc. S. Afr. Soc. Anim. Prod.* 5, 61.

WILLIAMS, C.H., DAVID, D.J. & IISMAA, O., 1962. The determination of chromic oxide in faeces samples by atomic absorption spectrophotometry. *J. agric. Sci., Camb.* 59, 381.

YOUNG, N.E., NEWTON, J.E. & ORR, R.J., 1980. The effect of a cereal supplement during early lactation on the performance and intake of ewes grazing perennial ryegrass at three stocking rates. *Grass and Forage Sci.* 35, 197.