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# Forage selection and performance of sheep grazing dry annual range

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The performance of sheep grazing a dry annual pasture in Israel was studied in relation to the vegetation on offer. During 114 days of grazing, sheep were found to select the fine fraction available with a higher nutritive value. As this fraction became depleted and feed quality dropped, organic matter intake (OMI) dropped from 1·73 to 0·75 kg/sheep/d. Sheep lost weight, body condition and body energy. They did not adjust grazing time to compensate for lower feed availability. Nevertheless, condition remained good enough to attain 100% mating and 134–166% lambing rates.

## Introduction

Animal husbandry in semi-arid pastoral regions is characterized by the grazing of dry annual vegetation during a long dry season. The amount and distribution of rainfall, in combination with the intensity of grazing during the rainy season, critically determine the quantity and quality of the forage available for livestock consumption in the dry season (Penning de Vries & Djitèye, 1982). In many semi-arid annual ranges, sheep must reproduce and maintain weight at a level necessary to support production functions while utilizing low quality, dry pastures during the summer. Grazing management under these conditions is a delicate balance of adjusting grazing intensity during both the pasture growing season when levels of lamb production are set, and the dry season, when ewes must reproduce. Very high stocking rates during the green season can maximize lamb meat production, but may decrease summer pasture availability with an increasing risk of low reproductive ability and high rates of mortality.

There is a wealth of information on the grazing of green growing pastures, but little information is available on the performance of grazing sheep in relation to the availability, characteristics and quality of the dry vegetation on offer. Information such as that provided by Carter (1978), is confined to the relationship between animal performance and dry matter (DM) availability in general. There is little information on the selective consumption of different species and of different parts of the vegetation on offer by sheep. The present paper reports on a study of the utilization efficiency of dry annual pasture species by sheep. The objectives of the study were to identify and define the physical and chemical characteristics of the dry pasture on offer to grazing sheep, to describe and quantify the dynamic changes of the pasture during the course of grazing, to determine sheep behaviour and estimate sheep intake as a function of changes in the availability of the vegetation components on offer, and to investigate the interactions between animal behaviour and intake responses to the changing availability of pasture components in relation to sheep performance.

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## Materials and methods

### *Site*

The experiment was conducted in the summer of 1979, at the Migda Experimental Farm, in the northern Negev of Israel (34°24′ EL, 31°22′ NL). The mean rainfall is 250 mm/year falling between November and May. The annual vegetation is dry from mid-April. Topography is flat to slightly undulating, and the soil is a deep loess (calcic xerochrept).

### *Pasture*

A 4·8 ha field of natural vegetation that was not grazed during the green season, was subdivided into four fenced plots of equal size for the experiment. Two of the plots (NPK1 and NPK2) were fertilized with $KNO_3$ for the past 8 years at a rate of 100 kg N/ha/year and with 60 kg $P_2O_5$/ha/year as granulated superphosphate. The other two plots (P1 and P2) only received 60 kg $P_2O_5$/ha/year. In each plot a 0·1 ha area was fenced off as an ungrazed control.

### *Grazing animals*

Two groups of sheep, each consisting of 15 mature German Mutton Merino × Finn ewes, one ram and 1 oesophageal fistulated (OF) Awassi ewe (Torell, 1954), began grazing NPK1 and P1 on July 3 (day 1). On day 57, the ewes were transferred from NPK1 to NPK2 and from P1 to P2. The experiment ended on day 114. During the experiment, the sheep had free access to water and shade at all times.

### *Vegetation*

Pasture availability in the grazed plots and their controls was estimated at the beginning of grazing and subsequently every 20 days by a calibrated weight-estimate technique (Tadmor, Brieghet *et al.*, 1975). At each measurement date, 150 eye estimates of standing biomass were made within a 20 × 20 cm quadrat in each plot. At every fifth estimate, vegetation inside the quadrat was collected and separated into three components:

(1) *standing vegetation*, upright plant structures, mainly stems, with some attached leaves and inflorescences.

(2) *litter (1)*, that could easily be collected by hand, consisting of broken stems, leaves and (parts of) inflorescences.

(3) *litter (2)*, that could only be collected by the use of a soft paint brush. It consisted of small leaf parts, seeds, parts of inflorescences, soil and bits of broken sheep faeces.

Litter (2) was cleaned from soil, faeces and small stones by passing the samples over a #60 mesh sieve. All samples were then weighed after drying for 24 h at 70°C. The resulting dry weights were used to calibrate the eye estimates and to calculate total biomass for each plot. The standing vegetation and litter (1) were subsequently separated into coarse and fine fractions. The coarse fraction consisted of relatively long and thick (more than 1 cm length and 0·25 cm diameter) parts of stems and inflorescences, while the fine fraction consisted of small pieces (less than 1 cm) of broken leaves, stems and parts of inflorescences (seeds, awns and supporting structures). For small plants, especially *Schismus arabicus*, a fine grass, the whole plant was considered part of the fine fraction, as was all of litter (2). After separation, all samples were redried at 70°C for at least 24 h and weighed to an accuracy of 0·01 g. All coarse and fine samples of each component were pooled and thoroughly mixed, for the determination of crude fibre and total N-content (AOAC, 1965).

*Diet selected*

An OF sheep was included in each of the two grazing flocks at all times. The two OF sheep were replaced by two others, when the flocks were transferred from plots, because of deterioration in body condition and liveweight. The behaviour of the OF sheep was not different from that of the other sheep. Oesophageal samples were collected every 7 days, beginning on July 9 (day 7). A sample was taken from each sheep at the onset of grazing, in the morning, usually at sunrise. A second sample was taken at 1500 h on the same day. The samples were collected after grazing periods of 20–60 minutes. Samples, including saliva, were dried at 70°C for up to one week. The samples were analysed for crude fibre and total-N content (AOAC, 1965).

*Behaviour*

At 2-weekly intervals, the behaviour of the flock and of some individual sheep in each plot was observed over a 24 h period, to estimate grazing time, (active collecting of herbage) resting time and time spent on other activities (walking, drinking and ruminating). During daylight, the activities of the flock and of the individual sheep were recorded every 5 minutes; at night only the activities of the flock were recorded every 15 minutes. It was assumed that sheep continued the activity recorded at any moment until the next observation.

*Performance parameters*

At 2-weekly intervals, sheep were withdrawn from access to pasture and water between 12 00–15 00 h and were weighed the following morning, at 6 00 h, to an accuracy of 100 g. At each weighing, body condition of the sheep was subjectively estimated (Jeffries, 1961), and body composition estimated using a tritium dilution technique (Benjamin, Degen *et al.*, 1973; Donnelly & Freer, 1974).

For the estimation of dry matter intake (DMI) and organic matter intake (OMI), the energy intake of the animals was estimated, using the equations of Blaxter and Boyne (1978), based on the organic matter, crude fibre and crude protein content of the diet selected (Figs 1 and 2) and the calculated energy gain or loss of the animals (Table 4). The estimated energy intake figures were scaled with OMI figures for maintenance requirements of animals grazing dry annual pasture as reported by Benjamin, Chen *et al.* (1977): 1·26 kg OMI/sheep/d (digestibility 0·53) or 0·83 kg OMI/kg liveweight $-0{\cdot}75$/d. Body energy content was calculated from their fat and protein content, assuming 1 kg fat to be equivalent to 39·35 MJ and 1 kg proteins equivalent to 22·5 MJ (Reid, Bensadoun *et al.*, 1968).

## Results

*Vegetation*

The botanical composition of the four plots at the end of the green season is given in Table 1. Despite similar treatment over 8 years for the plots NPK1 and NPK2, the species composition is completely different. However, all the major species are grazed by the sheep and all plots provided a selection of numerous species.

*Initial forage quantity and quality*

The NPK and P plots used in each grazing period initially had similar amounts of dry forage (Table 2), due to low rainfall in the growing season. However, Figs 1 and 2 show

**Table 1.** *Botanical composition of the four plots, expressed as percentages of total biomass, at the end of the 1978/1979 growing season (April 1979). The species have been identified according to Zohary (1977)*

| Species | NPK1 | NPK2 | P1 | P2 |
|---|---|---|---|---|
| *Schismus arabicus* Nees | 40 | 12 | 11 | 24 |
| *Hordeum leporinum* Link (formerly *Hordeum murinum*) | 25 | 2 | – | – |
| *Phalaris minor* Retz. | 10 | 35 | 8 | 6 |
| *Erucaria boveana* Coss. | 12 | 19 | 19 | 9 |
| *Asphodelus tenuifolius* Cav. | 3 | 29 | 45 | 47 |
| *Trigonella arabica* Del. | – | – | 10 | – |
| Others | 10 | 3 | 7 | 14 |

that the forage in the NPK plots had higher nitrogen (N) contents in both the coarse and fine fractions. These graphs also show that the replicate plots within each fertilizer treatment, though differing in botanical composition, did not differ in initial N and crude fibre (CF) content.

### *Change in forage quantity and quality during grazing*

The amount of forage declined rapidly after the beginning of grazing in each plot, due to the combined effects of consumption, trampling and wind transport. Within 31 days, the standing vegetation had disappeared completely and was reduced to litter (Table 2). In the ungrazed control plots, the standing vegetation remained. However, even there, total biomass declined as vegetation components were removed by ants (Messor spp.) and by wind (Table 3).

**Table 2.** *Dynamic changes in the different components (kg DM/ha) in the NPK1/P1 plots (grazed till day 57) and NPK2/P2 plots (grazed from day 57)*

| | Plots | | | | | |
|---|---|---|---|---|---|---|
| | NPK1/NPK2 | | | P1/P2 | | |
| Day | Standing vegetation | Litter(1) | Litter(2) | Standing vegetation | Litter(1) | Litter(2) |
| 0 | 1950 | 870 | 460 | 1500 | 710 | 580 |
| 10 | 1020 | 930 | 330 | 530 | 530 | 260 |
| 20 | 60 | 1260 | 420 | 40 | 790 | 450 |
| 31 | 40 | 640 | 440 | 0 | 420 | 400 |
| 42 | 0 | 490 | 270 | 0 | 310 | 360 |
| 50 | 0 | 490 | 760 | 0 | 210 | 390 |
| 57 | 0 | 340 | 500 | 0 | 190 | 300 |
| 57 | 860 | 610 | 340 | 630 | 430 | 550 |
| 70 | 160 | 880 | 620 | 210 | 490 | 540 |
| 80 | 50 | 760 | 400 | – | – | – |
| 84 | – | – | – | 0 | 410 | 340 |
| 87 | 30 | 710 | 360 | 0 | 380 | 450 |
| 98 | 0 | 530 | 180 | 0 | 320 | 230 |
| 108 | 0 | 490 | 280 | 0 | 210 | 250 |
| 114 | 0 | 510 | 240 | 0 | 220 | 200 |

**Table 3.** *Dynamic changes in the different components (kg DM/ha) in the control plots*

| | Plots | | | | | |
|---|---|---|---|---|---|---|
| | NPK1/NPK2 | | | P1/P2 | | |
| Day | Standing vegetation | Litter(1) | Litter(2) | Standing vegetation | Litter(1) | Litter(2) |
| 0 | 1890 | 1020 | 360 | 1220 | 700 | 520 |
| 27 | 970 | 1200 | 540 | 830 | 470 | 510 |
| 57 | 1350 | 1020 | 430 | 860 | 680 | 360 |
| 57 | 1140 | 670 | 420 | 900 | 290 | 440 |
| 97 | 1450 | 940 | 350 | 500 | 540 | 350 |
| 114 | 1100 | 830 | 300 | 640 | 410 | 290 |

Forage quality measurements of each fraction showed no consistent trend during the grazing periods, except for a decline in N content in the coarse fraction of the NPK2 plot in the second half of the grazing period (Figs 1 and 2). Figure 3 shows that the amount of the fine fraction (higher quality) decreased faster than the amount of the coarse fraction (lower quality). Thus, during grazing, the mean N content of the forage on offer declined continually, while the mean CF content increased.

## *Diet selected*

In the NPK plots, the N and CF contents of the diet selected were similar to those of the fine fraction during most of the experiment (Fig. 1). However, in the P plots, the N content of the diet selected was initially higher than that of the fine fraction, but fell below it later (Fig. 2). This indicates that, in the P plots, sheep preferentially selected a relatively small amount of high quality, fine material (possibly *Asphodelus tenuifolius* and *Trigonella arabica* pods and leaves), whereas later on, increasing amounts of coarse material were ingested.

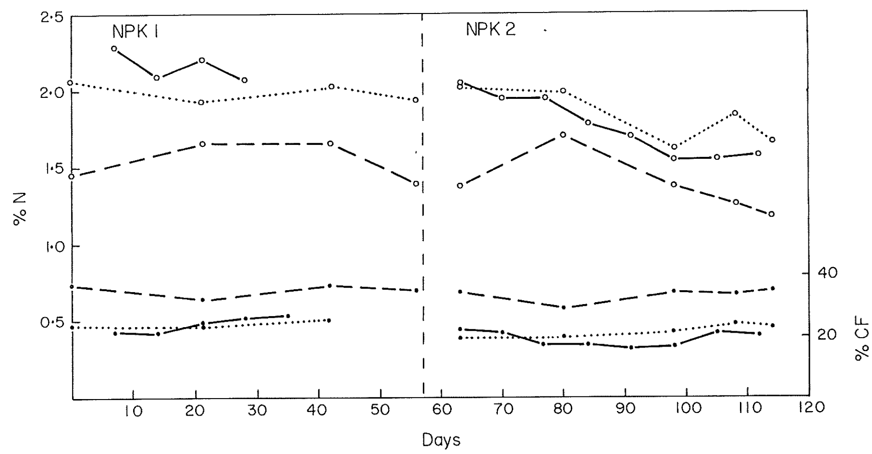


**Figure 1.** The time course of the N content and the crude fibre content in the coarse and fine fractions of the vegetation on offer and the diet selected, during grazing in the NPK1 and NPK2 plots. –, Coarse fraction; ....., fine fraction; ——, diet selected.

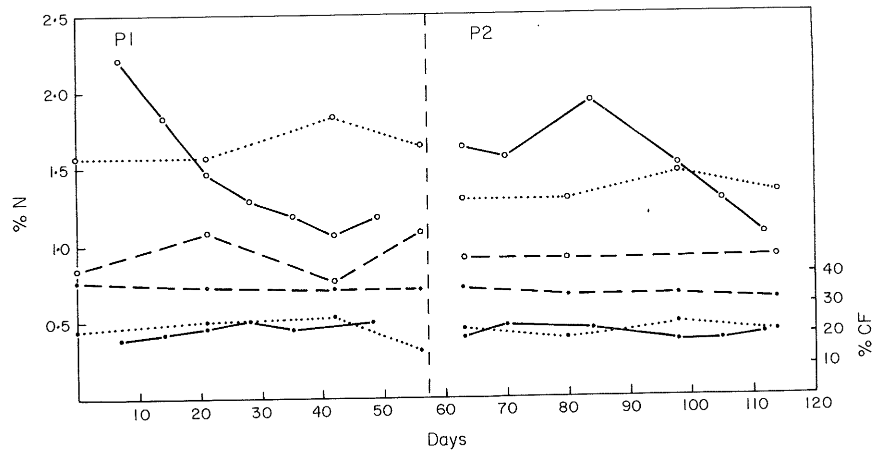


**Figure 2.** The time course of the N content and the crude fibre content in the coarse and fine fractions of the vegetation on offer and the diet selected, during grazing in the P1 and P2 plots. –, Coarse fraction; ....., fine fraction; ——, diet selected.

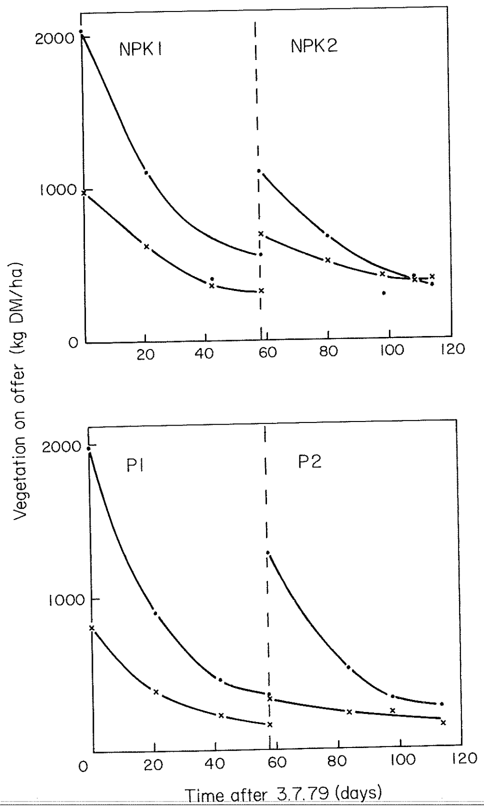


**Figure 3.** The time course of dry matter in the coarse and fine fractions of the vegetation on offer, during grazing in the NPK1/NPK2 and P1/P2 plots. ×, Coarse fraction; ●, fine fraction.

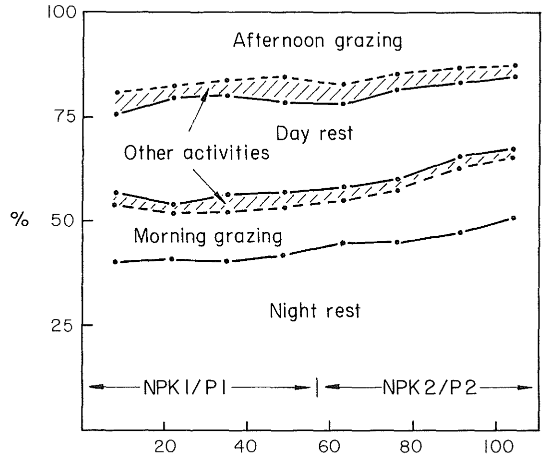


**Figure 4.** Period of the day spent in grazing, resting and other activities of an average sheep (means of NPK and P plots), expressed as percentages of 24 h.

### *Behaviour*

Four main sheep activities could be distinguished during a 24 h period: night-rest, morning grazing, day-rest and afternoon grazing (Fig. 4). No grazing was observed to occur at night. The periods of afternoon grazing became shorter with decreasing daylength during the course of the experiment. Sheep maintained total grazing time by shortening the day-rest period at low forage availabilities towards the end of the grazing periods in each plot. Climatic or feed availability stress did not seem to influence total grazing time.

### *Sheep performance*

Table 4 shows that the average liveweight, fat content and body condition of the flock grazing the P plots were higher than those of the flock grazing the NPK plots at the beginning of the experiment, whereas the opposite was true at the end of the experiment. Liveweight increased at the beginning of grazing in all but the NPK2 plot, but this was mainly caused by an increase in total body water content (TBW). Fat content gradually decreased in both flocks, although there was a tendency for some recovery when the flocks were transferred to the new plots. Consequently, the body energy content followed a similar pattern. OMI and DMI (Table 5) were higher during the first two weeks of grazing in each plot and decreased to lower values in the course of grazing. Over the whole experiment, the decrease in OMI was more pronounced in the NPK plots than in the P plots.

The mating and lambing performance of the sheep is shown in Table 6. More ewes were mated initially in the P1 plot, but after 39 days there was little difference between ewes in the NPK1 and P1 plots. Lambing rates were higher for ewes grazing the NPK plots.

## Discussion

### *Animal intake*

The observed similarity in chemical composition between the fine fraction of the vegetation and the diet selected, indicates a strong preference by the sheep for that fraction. This may be partly due to physical factors, since the coarse fraction contains the hard

**Table 4.** *Averages (± SE) of liveweight, body composition and body condition of sheep grazing the NPK and P plots (TBW = total body water content; W–Z = Liveweight minus 1·5 kg/sheep fleece–weight). At day 57 sheep were transferred from NPK1 and P1 plots to NPK2 and P2 plots, respectively*

| | Plots | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NPK1 | | | | | | NPK2 | | | |
| Day | 0 | 15 | 29 | 36 | 43 | 57 | 71 | 85 | 100 | 113 |
| No. of sheep | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 11 | 11 |
| Liveweight (kg) | 51·7 | 55·0 | 53·4 | 53·2 | 53·1 | 52·8 | 51·4 | 50·6 | 47·8 | 47·5 |
| ± SE | 2·1 | 2·3 | 2·2 | 2·3 | 2·2 | 2·2 | 2·0 | 2·0 | 2·1 | 2·0 |
| Liveweight OF (kg) | 46·2 | 40·0 | 36·1 | 34·5 | 35·6 | – | 42·0 | 43·8 | 44·5 | 42·9 |
| TBW (kg) | 32·5 | 34·9 | 34·5 | 35·0 | 35·4 | 36·0 | 35·3 | 35·2 | 33·5 | 33·0 |
| ± SE | 1·2 | 1·4 | 1·3 | 1·5 | 1·5 | 1·7 | 1·5 | 1·6 | 1·7 | 1·8 |
| % of W–Z | 66 | 66 | 68 | 69 | 70 | 71 | 72 | 73 | 73 | 72 |
| Fat (kg) | 7·9 | 8·2 | 7·5 | 6·8 | 6·3 | 5·4 | 4·9 | 4·4 | 3·7 | 4·0 |
| ± SE | 1·0 | 1·1 | 1·1 | 1·0 | 0·9 | 0·8 | 0·7 | 0·6 | 0·5 | 0·6 |
| % of W–Z | 15 | 15 | 14 | 13 | 12 | 10 | 10 | 9 | 8 | 9 |
| Energy (MJ) | 456 | 479 | 441 | 412 | 395 | 359 | 337 | 316 | 284 | 292 |
| ± SE | 43 | 46 | 44 | 43 | 40 | 35 | 29 | 25 | 20 | 22 |
| Energy gain/d (MJ) | – | 1·53 | −2·71 | −4·14 | −2·43 | −2·57 | −1·57 | −1·50 | −2·13 | 0.62 |
| Body condition | – | 2·5 | 2·5 | – | 2·5 | 2·0 | 2·2 | 2·1 | 2·1 | 1·9 |
| ± SE | | 0·2 | 0·2 | – | 0·2 | 0·1 | 0·1 | 0·1 | 0·1 | 0·1 |

| | Plots | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P1 | | | | | | | P2 | | |
| Day | 0 | 15 | 29 | 36 | 43 | 57 | 71 | 85 | 100 | 113 |
| No. of sheep | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 14 | 13 | 13 |
| Liveweight (kg) | 53·4 | 55·8 | 52·7 | 52·2 | 51·8 | 50·4 | 51·5 | 49·5 | 46·6 | 46·7 |
| ± SE | 1·7 | 1·7 | 1·5 | 1·8 | 1·7 | 1·7 | 1·6 | 1·6 | 2·1 | 2·0 |
| Liveweight OF (kg) | 44·0 | 43·8 | 44·6 | 44·4 | 42·9 | 41·7 | 42·7 | 41·0 | 39·0 | – |
| TBW (kg) | 31·5 | 33·6 | 31·3 | 31·6 | 32·2 | 32·1 | 32·8 | 32·3 | 30·8 | 30·2 |
| ± SE | 1·0 | 1·1 | 1·1 | 1·0 | 0·9 | 1·0 | 0·9 | 1·2 | 1·3 | 1·4 |
| % of W–Z | 62 | 64 | 62 | 63 | 65 | 67 | 67 | 68 | 69 | 68 |
| Fat (kg) | 10·9 | 10·7 | 10·2 | 9·5 | 8·4 | 7·2 | 7·4 | 6·3 | 5·5 | 6·0 |
| ± SE | 1·5 | 1·1 | 1·2 | 1·2 | 1·1 | 1·0 | 0·9 | 0·9 | 0·9 | 0·8 |
| % of W–Z | 22 | 19 | 19 | 16 | 16 | 14 | 14 | 11 | 12 | 13 |
| Energy (MJ) | 580 | 576 | 547 | 519 | 478 | 427 | 438 | 387 | 350 | 370 |
| ± SE | 63 | 58 | 48 | 49 | 47 | 41 | 37 | 37 | 37 | 34 |
| Energy gain/d (MJ) | – | –0·27 | –2·07 | –4·00 | –5·90 | –3·64 | 0.78 | –3·64 | –2·47 | 1.54 |
| Body condition | – | 2·7 | 2·3 | – | 2·3 | 1·8 | 2·0 | 2·1 | 2·0 | 1·7 |
| ± SE | | 0·2 | 0·2 | – | 0·3 | 0·1 | 0·1 | 0·2 | 0·1 | 0·1 |

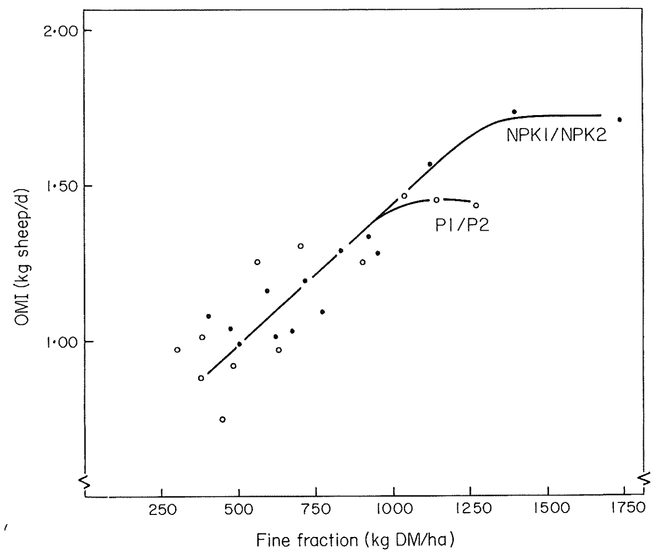


**Figure 5.** The relation between amount of fine fraction in the vegetation on offer and OMI of the sheep when grazing NPK and P plots.

stemmy parts as well as *Hordeum leporinum* inflorescences, with their barbed awns. However, the difference in nutritive value could also play a role, since the stem material inherently has a lower N and a higher CF content than the leaves, which constitute a major part of the fine fraction. Selection of the fine fraction was strong, even though it was relatively less accessible than the coarse fraction. Sheep were observed to push aside overlying coarse material, to consume the fine material close to the soil surface. OMI is

**Table 5.** *DMI and OMI ± SE) estimates of the sheep in kg/sheep/day when grazing the NPK and P plots. At day 57 sheep were transferred from the NPK1 and P1 plots to the NPK2 and P2 plots, respectively*

| | Plots | | | |
|---|---|---|---|---|
| | NPK1/NPK2 | | P1/P1 | |
| Days | DMI (kg/sheep/day) | OMI (kg/sheep/day) | DMI (kg/sheep/day) | OMI (kg/sheep/day) |
| 7 | 2·04 (±0·14) | 1·70 (±0·12) | 1·76 (±0·16) | 1·43 (±0·13) |
| 14 | 2·07 (±0·14) | 1·73 (±0·12) | 1·71 (±0·16) | 1·45 (±0·13) |
| 21 | 1·87 (±0·23) | 1·56 (±0·19) | 1·47 (±0·15) | 1·25 (±0·12) |
| 28 | 1·65 (±0·18) | 1·33 (±0·12) | 1·57 (±0·15) | 1·30 (±0·13) |
| 35 | 1·30 (±0·16) | 1·09 (±0·14) | 1·60 (±0·26) | 1·25 (±0·20) |
| 42 | 1·45 (±0·18) | 1·03 (±0·13) | 0·97 (±0·17) | 0·75 (±0·11) |
| 49 | 1·38 (±0·15) | 1·01 (±0·11) | 1·08 (±0·12) | 0·88 (±0·10) |
| 64 | 1·62 (±0·14) | 1·28 (±0·11) | 1·78 (±0·16) | 1·46 (±0·13) |
| 71 | 1·72 (±0·15) | 1·29 (±0·11) | — | 1·73 (±0·15) |
| 78 | 1·70 (±0·14) | 1·19 (±0·11) | 1·25 (±0·19) | 0.97 (±0·14) |
| 85 | 1·51 (±0·15) | 1·16 (±0·11) | 1·16 (±0·17) | 0·92 (±0·13) |
| 92 | 1·30 (±0·18) | 0·99 (±0·13) | 1·33 (±0·19) | 1·01 (±0·12) |
| 99 | 1·48 (±0·20) | 1·04 (±0·14) | 1·30 (±0·17) | 0·97 (±0·12) |
| 106 | 1·44 (±0·16) | 1·08 (±0·12) | — | 1·22 (±0·14) |

**Table 6.** *Number of ewes mated and lambing rates per ewe in flocks grazing the NPK and P plots*

| Days from beginning of grazing | NPK plots | | P plots | |
|---|---|---|---|---|
| | No. of ewes mated | Lambing rate | No. of ewes mated | Lambing rate |
| 18 | 1 | 2·00 | 4 | 1·50 |
| 39 | 7 | 1·86 | 3 | 1·34 |
| 46 | 2 | 1·00 | 1 | 1·00 |
| 50 | 3 | 1·34 | 4 | 1·50 |
| 63 | 2 | 1·50 | 3 | 1·00 |
| Total | 15 | 1·66 | 15 | 1·34 |

linearly related to the availability of the fine fraction over a wide range of values (Fig. 5). At high levels of availability, OMI reaches a saturation value, which is somewhat higher in the NPK plots than in the P plots. This may be due to a higher average N content in the former (Figs 1 and 2). Selection of specific components of the vegetation on offer when grazing semi-arid rangeland is also described by Bishop, Froseth *et al.* (1975), who found low intakes in comparison with the vegetation on offer, since 'animals preferentially grazed certain species, even when these were present in very low amounts'. This could also have been due to physical factors, as the rejected species were two coarse perennials, *Sporobolus rigens* and *Hyalis argenta*.

*Animal behaviour*

The grazing behaviour indicated that no attempt was made to increase grazing time with falling availabilities of both total vegetation and its fine fraction. Grazing time varied from 6·5–8 h per day, and was shown to be restricted to about 4 h in the morning and 4 h in the afternoon, roughly corresponding to times when ambient temperatures were below 30°C. If anything, there was a tendency to shorten daily grazing time from 8 h initially to a minimum of 6·5 h, as vegetation availability declined. It appeared that the sheep were satisfied by whatever intake they achieved during a relatively constant total grazing time, despite the fact that they were not achieving potential intake levels (1·7 kg DM/d in this experiment) and were losing liveweight, body condition and body energy. The mean

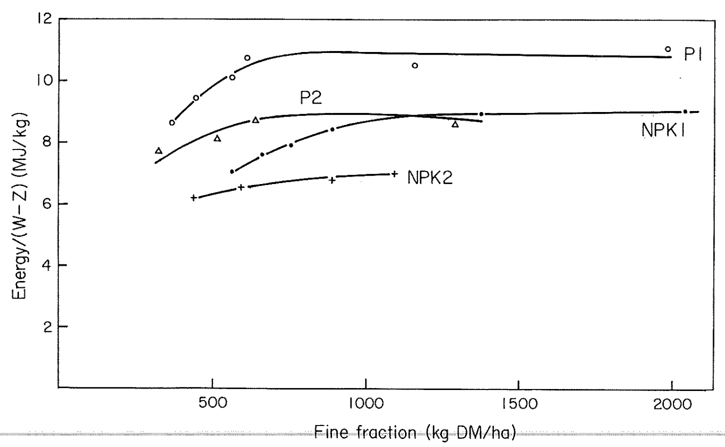


**Figure 6.** Time course of the energy content of the sheep in relation to the fine fraction in the vegetation on offer.

water intake was relatively constant over the study period, at 4·6 kg/sheep/d, regardless of pasture availability, intake or ambient temperatures.

### *Animal performance*

Energy content of the sheep (MJ kg/(W–Z)) has been related to availability of the fine fraction in Fig. 6. Below values of about 750 kg DM/ha body energy losses are higher in the NPK1 and P1 plots than in the NPK2 and P2 plots. This is possibly due to the higher CF content in the diet selected and the higher liveweights (higher maintenance requirements) of the sheep grazing those plots. After initial gains, the sheep gradually lost liveweight, body condition and body energy throughout the experiment (Table 4), as was found in previous experiments (Tadmor, Eyal *et al.*, 1974). Then, liveweight losses were ascribed to the low mean nutritive value of the vegetation on offer. However, in this study vegetation components of a relatively high crude protein content and presumably high nutritive value, were available at all times (over 400 kg DM/ha).

The behaviour and performance of the sheep in this experiment, suggest that their level of intake was commensurate with the amount of preferred vegetation components that they could gather in a relatively constant grazing time of 6·5–8 h per day. Initial high availability allowed intakes high enough to meet maintenance requirements, but with decreasing availability, intakes declined to a level that possibly resulted in a minimum rumen fill that could satisfy a hunger urge. Beyond this level of intake, the sheep made no effort to increase their intake to meet other requirements, possibly because searching for and gathering preferred pasture components in high ambient temperatures entailed too great an energy expenditure.

The mating and lambing rates of the ewes in both flocks suggest that the loss of liveweight, body condition and body energy at the rates recorded in this study were not drastic enough to affect breeding performance. The lambing percentage of the ewes grazing the NPK plots was similar to that recorded for ewes of the same breed fed up to 0·5 kg of concentrate supplements while grazing wheat aftermaths in an adjacent field. The higher lambing rate of the ewes grazing the NPK plots is related to better body condition, which could have been a result of the higher protein fraction in the N-fertilized vegetation.

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