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Group size effects on grazing behaviour and efficiency in sheep

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Abstract

Two grazing trials were conducted during early winter (January 1996) and spring (April 1996) to evaluate the effect of group size on grazing efficiency and behaviour of sheep. Three treatments were tested, large (LG), medium (MG) and small group size (SG), with 2 replicates for each treatment of 12, 9, and 6 ewes, respectively. Groups were homogeneous for age and weight. Paddock size furnished 10 m^2 per sheep per day. Group size did not affect grazing efficiency and herbage intake in the winter, but in the spring, when herbage mass was more plentiful, the ewes in the small groups grazed shorter, had a lower herbage intake and a less efficient use of forage. Consequently, the sheep in the small groups gained less weight than those in the large groups in spring. Neither group size nor seasonal changes in forage quantity or quality influenced sheep selectivity. These results suggest that the choice of a proper flock size at pasture can play a major role in optimizing grazing efficiency in sheep, especially when feeding is largely based on grazing, as generally occurs in countries of the Mediterranean basin in spring. Under the conditions of this study, our results indicate that a flock size of more than 6 sheep should be used for studies on sheep grazing behaviour.

Key Words: diet quality, grazing management, intake

Resumen

Se condujeron dos ensayos de apacentamiento durante el inico del inviero (Enero de 1996) y primavera (Abril de 1996) para evaluar el efecto del tamaño de grupo en el comportamiento y eficiencia de apacentamiento de ovinos. Se probaron tres tratmientos, grupo grande (LG), grupo mediano (MG) y grupo pequeño (SG) con dos repeticiones por tratamiento de 12, 9, y 6 borregas respectivamente. Los grupos eran homogénos en cuanto edad y peso. De acuerdo con el tamaño de potrero a cada borrego se asignaban 10 m^2 diarios. En invieron, el tamaño del grupo no afectó ni la eficiencia de apacentamiento ni el consumode forraje; sin embargo, en primavera cuando hubó más forraje disponible las borregas de los grupos pequeños apacentaron menos, tuvieron más bajo consumo de forraje y menos eficiencia del uso de forraje. Consecuentemente, en primavera, los borregos de los grupos pequeños ganaron menos peso que los de los gupos grandes. La selectividad de los borregos no fue influenciada ni por el tamaño de grupo ni por los cambios estacionales de calidad y cantidad de forraje. Estos resultados sugieren que la elección de un tamaño adecuado de rebaño puede jugar un papel importante en la optimización de la eficiencia de apacentamiento de los borregos, especialmente cuando la alimentacion es basada en apacentamiento, como generalmente ocurre en primavera en paises de la cuenca del Mediterráneo. Bajo las condiciones de este estudio, nuestros resutados indican que un rebaño de más de 6 borregos debe ser utilizado para estudios de comportamiento de apacentamiento de borregos.

Grazing plays a major role in sheep feeding. Understanding the factors that affect sheep grazing behaviour and grazing efficiency may reduce feeding costs and improve sheep growth rate and reproductive performance. The ingestive behaviour of grazing sheep is seasonally affected by several factors including the animal's endocrine and metabolic state and the effects of climate on forage quality and quantity (Lynch et al. 1992). Stocking rate and flock size may also influence grazing behaviour and feed intake, because sheep are social animals (Rook and Penning 1991; Penning et al. 1993; Scott et al. 1996) and because they are selective grazers (Forbes, 1995). Selectivity is related to the number of grazing sheep and the amount of available herbage, i.e. grazing pressure (Lynch et al. 1992).

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Several authors have assessed the effect of stocking rate on sheep grazing efficiency and behaviour relative to grazing duration (Heitschmidt and Walker 1983, Sharrow 1983; Stoltz and Danckwerts, 1990; Ali and Sharrow, 1994), sward characteristics (Penning et al. 1991), season (Birrell 1991) and shape of paddock (Lynch and Hedges, 1979). Little is known about the effects of group size on sheep grazing behaviour. In flocks ranging from 1 to 15 ewes Penning et al. (1993) found reduced grazing times in small flocks, assuming that sheep in larger groups may benefit from social facilitation and/or from the increased number of individuals that are vigilant. There is little information on the effect of flock size on sheep grazing efficiency and behaviour or the influences of seasonal climatic effects or pasture conditions. The purpose of this study was to investigate the effects of group size on sheep grazing efficiency and behaviour during the winter and the spring seasons.

Materials and Methods

The experimental site was approximately 30 kilometers northeast of Foggia, Apulia, Southern Italy (latitude: 41° 27' 6" and longitude: 15° 33' 5"), with an elevation of about 100 metres above sea level. The climate of this area is Mediterranean, with about 500 mm of annual rainfall, mainly distributed in late autumn and winter, and a 22.1°C mean maximum temperature (often over 30°C from June to August). Rainfall, temperature, humidity, sun radiation, wind speed, and daily sunshine hours, were recorded throughout the trials at the meteorological station of the Capitanata Land-Reclamation Syndicate, about 0.5 km away from the site of experiment (Table 1). The area is covered by quaternary and recent alluvial soils. Sandy-silicious and alluvial soils are prevalent (24% and 21%, respectively), followed by clayey-calcareous soils (16%), calcretes (15%) and clayey-silicious soils (10%). The study pasture was composed of Graminaceae predominantly (*Lolium* spp., *Festuca* spp.) and to a smaller extent of Cruciferae, Compositae (*Carduus* spp.) and Leguminosae (*Trifolium* spp.). The above mentioned botanical families and genera were nearly always distributed in very complex mixes.

Grazing trials were conducted during early winter (January 1996) and spring (April 1996), and 54 dry Comisana ewes were used in each trial. Both trials lasted 30 days with each divided into three, 10-day grazing periods. Trials were preceded by a 7-day acclimation period so ewes could become acquainted with their peers. During this period the sheep grazed similar paddocks, adjacent to the experimental pastures. All ewes were familiar with forage found in pastures.

Three group sizes were tested, large group (LG, n=12) vs medium group (MG, n=9) vs small group (SG, n=6), with 2 replicates for each treatment. The ewes of the experimental groups were homogeneous for age (approximately 3 years) and weight (58 kg on average).

Table 1. Climatic data recorded throughout winter (January 1996) and spring (April) 1996 trials.

	Winter			Spring		
	Min	Max	Mean	Min	Max	Mean
Rainfall (mm/day)	0	15.6	3.5	0	5.6	1.3
Temperature (°C)	0.4	9.8	5.1	7.2	23.7	15.5
Humdity (%)	67.1	92.3	79.7	39.4	82.5	60.9
Sun radiation (W/m^2)	9.5	89.3	60.6	41.1	281.4	208.2
Wind speed (m/s)	0.58	5.11	2.89	1.25	6.08	2.92
Daily sunshine hours (n)	9.17	9.51	9.28	13.55	14.52	14.07

Paddock size was varied among treatments (60m x 20m, 50m x 18m, and 43m x 14m for LG, MG, and SG groups, respectively) to maintain a constant stocking rate of 10 m^2 per sheep per day. On average, daily forage allowance was 1.35, 1.39, and 1.36 kg DM/ewe/day in the winter and 1.89, 1.90 and 1.92 kg DM/ewe/day in the spring for LG, MG and SG treatments, respectively. Herbage composition was similar among the experimental groups. Paddocks were contiguous with mesh-fence boundaries. The groups of animals were somewhat isolated visually by rows of olive trees. Every day the ewes grazed from 09:00 hours to 17:00 hours with the rest of the day spent in separate straw-bedded pens. When the ewes returned to their own pens they were given vetch/oat hay (1.0 kg in winter and 0.5 kg in spring per head) and barley (0.25 kg per head in winter).

Measurements

Forage mass and composition was determined before and after each grazing period (10 days) by harvesting all herbage within 8 randomly selected 1 m^2 quadrates to ground level in all paddocks. Samples were dried in an oven at 50°C for 48 hours before weights were recorded. Herbage samples, as well as hay and barley (Table 2), were analysed for fat, crude protein, crude fibre, and ash (AOAC 1984). Average daily forage and nutrient intake was calculated as the difference between pre-grazing and post-grazing forage mass divided by ewe number x grazing period duration. Post-grazing forage mass was adjusted for growth during each period using estimates of pasture growth derived from cutting 8 randomly selected 1 m^2 quadrates in adjacent ungrazed pasture at the beginning and the end of each grazing period. Pasture utilisation efficiency was calculated as the ratio between forage intake and forage availability. The live-weights of the ewes were recorded at the beginning of the trial and subsequently every 10 days.

The grazing behaviour of the ewes was recorded by 3 trained observers equipped with video cameras on the 3rd, 6th and 9th day of each grazing period. Behavioural observations were conducted from 09:00 hours to17:00 hours and were divided into 60 min periods for each group. A different focal animal was chosen at random every day in each group and the 60 min observation periods were systematically rotated among treatments and replicates. Times spent eating, ruminating, standing inactive, resting, walking, defecating and urinating, exploring, and in other activities (self-grooming, grooming, scratching oneself, bleating, fencing biting) were recorded.

Table 2. Chemical composition and nutritive value of hay, barley and herbage.

	Vetch/oat hay	Barley	Herbage	
			Winter	Sping
Dry matter (%)	83.4	88.1	22.5	21.2
Crude protein (% DM)	14.1	12.7	16.9	19.1
Fat, by ether extract (% DM)	1.8	2.2	3.3	3.6
Crude fibre (% DM)	31.0	5.6	25.1	22.0
Ash (% DM)	9.1	2.7	10.1	10.2
N-free extract (% DM)	44.0	76.8	44.6	45.1
Gross energy (MJ/kg DM)	18.4†	18.6††	18.7†	20.3††

†Evaluated according to the equation by Lanari et al. (1993). ††Evaluated according to the equation by Schiemann et al. (1971).

Table 3. Estimated feed and nutrient intake and pasture utilisation efficiency (PUE) for large, medium and small groups in the winter and the spring trials.

	From herbage						From the supplements	
	Winter			Spring			Winter	Spring
	LG	MG	SG	LG	MG	SG		
DM intake								
(kg ewe/day)	0.75±0.lc	0.73±0.lc	0.71±0.lc	1.32±0.la	1.24±0.la	1.08±0. lb	1.05	0.42
Crude protein intake								
(g/ewe/day)	1 50.0±3.2c	147.5±2.7c	146.3±2.8c	286.4±3.0a	274.0±3.5a	240.8±2.9b	145.6	58.8
(% on DM)	20.0±0.5	20.2±0.4	20.6±0.5	21.7±0.4	22.1±0.3	22.3±0.5		
Fat intake								
(g/ewe/day)	24.0±0.3b	26.3±0.3b	27.0±0.4b	50.2±0.4a	49.6±0.4a	43.2±0.4a	19.9	7.5
(% onDM)	3.2±0.1	3.6±0.1	3.8±0.1	3.8±0.1	4.0±0.2	4.0±0.1		
Crude fibre intake								
(g/ewe/day)	155.3±3. 1c	151.1±1 .7c	144.8±2.4c	250.8±4. la	234.4±4.2a	200.9±3.8b	270.9	129.3
(% on DM)	20.7±0.2	20.7±0.3	20.4±0.2	19.0±0.4	18.9±0.4	18.6±0.5		
Ash intake								
(g/ewe/day)	78.8±1.7c	75.9±1.5c	74.6±1.8c	146.5±2.la	141.4±1.8a	121.0±1.9b	76.5	37.9
(% onDM)	10.5±0.2	10.4±0.2	10.5±0.2	11.1±0.3	11.4±0.2	11.2±0.2		
Gross energy								
(MJ/ewe/day)t	19.6±0.3c	19.6±0.4c	19.6±0.4c	21.3±0.3a	21.2±0.3a	20.7±0.4b	19.4	7.7
PUE (%)	55.6±2.lc	52.5±l.6c	52.2±l.6c	69.8±1.4a	65.3±1.8a	56.3±1.5b		

[t] Evaluated according to the equation by Lanari et aL (1993). Means within the same line followed by different letters are significantly different at P<0.05.

Statistical Analysis

Pasture and behavioural variables were subjected to analysis of variance for repeated measures (SAS 1990) and the following model was adopted: $y_{ijklm} = \mu + \alpha_i + \beta_{ij} + \chi_k + \delta_l + (\alpha\chi)_{ik} + (\alpha\delta)_{il} + (\chi\delta)_{kl} + (\alpha\chi\delta)_{ikl} + \varepsilon_{ijklm}$ where: γ_{ijklm} = experimental observation; μ = overall mean; α_i = group size; β_{ij} = replicate within group size; χ_k = season; δ_l = day of observation; $(\alpha\chi)_{ik}$ $(\alpha\delta)_{il}$ $(\chi\delta)_{kl}$ and $(\alpha\chi\delta)_{ikl}$ = interactions; ε_{ijklm} = random error. Group size, season and group size by season were sources of variation for the body weight and body weight changes of the ewes. When significant effects were found, the Student T test was used to locate significant (P<0.05) differences between means.

Results and Discussion

The data on herbage intake and pasture utilisation efficiency are reported in Table 3. Dry matter and nutrient intakes were higher in the spring than in the winter, depending on quantitative and qualitative supplement characteristics offered at each season (Avondo et al. 1995) and less on seasonal changes of herbage allowance and composition (Forbes 1995).

Group size did not affect herbage intake and pasture utilisation efficiency in the winter, but in the spring the ewes in the small groups had significantly smaller herbage and nutrient intakes and a lower pasture utilisation efficiency than the ewes in the medium and large groups. Based on measurements of changes in sward surface height, Penning et al. (1993) also reported a negative effect of small group sizes on herbage intake of sheep. Our results indicate that seasonal differences in level of supplementation and in herbage availability can play a major role in highlighting such differences of herbage intake.

Neither group size nor seasonal changes in pasture conditions seemed to have a direct effect on diet selection. Differential feed supplementation given to sheep in pens might partially account for the lack of shift in selectivity as well as for differences of herbage intake at pasture between the winter and the spring seasons (Jarrige 1988).

In both trials, grazing sheep spent a large part of the time (about 55 to 70%) eating (Table 4). Throughout the winter trial, eating times were similar among

Table 4. Grazing behaviour of large, medium and sm,all groups in the winter and the spring trials.

		Winter			Spring		
		LG	MG	SG	LG	MG	SG
Eating	(mm/day)	273.1±8.4b	275.0±7.7b	271.8±7.6b	334.0±8.la	303.2±8.4a	286.5±7.9b
Ruminating	(mm/day)	22.1±1.7	20.4±0.6	19.3±1.2	23.6±1.1	28.8±1.3	21.5±0.9
Standing	(mm/day)	28.1±2.3	27.6±1.4	28.2±1.3	27.2±0.9	29.2±1.2	26.8±1.0
Resting	(mm/day)	85.5±2.la	77.4±1.8ab	44.7±1.9c	58.9±1.4b	52.1±1.1b	40.1±1.3c
Walking	(mm/day)	38.8±1.7b	36.1±0.9b	57.0±1.4a	10.8±l.lc	24.7±0.9bc	56.8±1.2a
Defecat.+urinat.	(mm/day)	12.4±1.5	14.0±1.1	8.1±1.2	7.9±0.9	13.2±0.9	5.2±0.5
Exploring	(mm/day)	9.6±1.7b	14.1±1.lb	35.8±1.3a	6.3±0.6b	13.2±0.8b	33.3±0.9a
Otheractivities	(mm/day)	10.4±1.1	15.4±2.0	15.1±0.9	11.3±0.7	15.6±1.1	9.8±0.7

Means within the same line followed by different letters are signilicantly different at P<0.05.

Table 5. Body weight changes (BWC) of the ewes in large, medium, and small groups in the winter and the spring trials.

		Winter			Spring		
		LG	MG	SG	LG	MG	SG
Initial body weight	(kg)	57.30±1.4	58.01±1.4	58.83±1.2	58.06±1.6	58.21±1.5	57.63±1.6
Finalbodyweight	(kg)	57.63±1.6	58.17±1.1	58.68±0.9	58.96±1.4	58.81±1.4	57.81±1.2
BWC	(g/d)	11.1±0.lab	5.2±0.1b	-5.1±0.1	30.1±0.la	19.9±0.lab	6.1±0.2b

Means within the same line followed by different letters are significantly different at P.<0.05.

the treatments, while in spring the SG ewes exhibited markedly lower eating times than the large group (LG) and the medium group (MG) ones. These results matched the differences observed for herbage intake among the groups. In both trials, the ewes in the small groups spent less time resting and differences were more evident in winter. Overall, resting times were higher in the winter season, resting close together presumably is for thermoregulatory purposes. Time spent walking and exploring was higher in the small than in the large and medium groups; walking took a longer time in the winter than in the spring season, too. According to Penning et al. (1993), the longer time spent in exploratory behaviour by the ewes in the small groups might be ascribed to an ancestral behaviour correlated with the level of perceived danger of predation. Security may be derived from the increased number of sheep that are vigilant in larger groups (Pulliam 1973). In addition, the less effective social exploration the smaller the group (Fraser and Broom 1990) and since animals give a very high priority to exploration, it is not surprising that such behaviour may steal time also from feeding activity. The stronger kinetic drive of ewes in small groups to investigate the environment might be responsible for their increased locomotion (Carson 1985). Differences of time spent walking during winter and spring trials might be attributed to changes in herbage allowance or quality. Walking, which is part of searching behaviour (Gluesing and Balph 1980), may also be affected by availability and location of food (Fraser and Broom 1990). Due to less energy intake and/or a greater loss of energy form walking or exploring, the ewes in the small groups gained less weight than those in the medium and large groups in the spring (Table 5).

Management Implications

McClymont (1967) reported social facilitation of feeding behaviour in sheep and Southcott et al. (1962) found that animals maintained in smaller group sizes gained less weight than those maintained in larger group sizes. More recently Penning et al. (1993) observed that sheep in small groups spent less time grazing than those in large groups and that animals in groups of 1 or 2 tended to have shorter meals than those in groups of 3 to 15, assuming a reduced intake of herbage in groups of less than 4 sheep, too. Our results confirm previous findings and hypotheses, adding further information about the factors affecting herbage intake in flocks of different group sizes. First, our results suggest that both pasture conditions and level of supplementation must be taken in account to evaluate correctly the effect of group size on sheep feeding behaviour at pasture; in fact, differences in grazing time, pasture utilisation efficiency, herbage intake and body weight changes were small and not significant in the winter, whereas they were more evidently in favour of medium and large groups in the spring, when sheep feeding was largely based on grazing. In both trials, but especially in the spring, the ewes in the small groups spent more time in alternative behaviours, such as walking and exploring, to ingestive activity detriment, and this resulted not only in a reduced herbage intake but also in a greater waste of energy, both perhaps responsible for reduced weight gains. Hence, the importance of social facilitation for feeding at pasture in sheep is confirmed. Under the conditions of this study the existence of a group size effect on grazing behaviour of sheep also for groups of more than 4 animals is demonstrated. Thus, our results clearly indicate that flock size at pasture may be a critical variable in determining grazing behaviour and efficiency of sheep, especially when feeding is largely based on grazing, as generally occurs in countries of the Mediterranean basin in spring. Our findings also indicate that a minimum flock size of more than 6 sheep is required for studies that are investigating grazing time and intake of sheep.

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