Cattle and sheep performance during summer grazing on high mountain ranges in extensive production systems

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Cattle and sheep performance during summer grazing on high mountain ranges in extensive production systems

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SUMMARY – The weight gains of sheep and cattle in different physiological stages during the summer grazing period in Pyrenean high mountain ranges have been studied. 534 records of lactating spring-calving cows, 405 spring-born calves and 285 pregnant autumn-calving cows were collected over seven years. Autumn-calving cows had higher and more constant gains (0.43 kg/day) than spring-calving cows (0.30 kg/day), which had wide between-year variations. However, their calves had high and constant weight gains (0.9 kg/day), reflecting that their dams buffered year climatic effects by mobilising their reserves and providing enough milk for adequate calf growth. 266 records of lactating, pregnant and dry ewes were collected over a three-year period. Lactating sheep had the higher weight losses (–7.1 kg / 3 months), although pregnant and non-lactating sheep also showed a moderate loss (around –4 kg). The low performances of both species were probably due to the low herbage quality (6.7 MJ ME/kg DM) and the high energy requirements caused by the long distances and vertical movements that the animals travelled daily.

Key words: Beef cattle, sheep, mountain production systems, summer grazing.

***RESUMÉ –** "Performances des bovins et ovins pendant le pâturage d'été dans des systèmes de production extensifs en haute montagne". Les gains de poids pendant le pâturage d'été en estive de vaches et brebis de stades physiologiques différents ont été étudiés. 534 vaches vêlant au printemps, 405 veaux nés au printemps et 285 vaches vêlant en automne ont été contrôlées pendant 7 années. Les vaches vêlant en automne ont gagné plus de poids (0,43 kg/jour) que celles vêlant au printemps (0,30 kg/jour), ces dernières présentant de grandes variations interannuelles. Les veaux ont eu des gains élevés et constants entre années : cela reflète que les mères ont mobilisé leurs réserves corporelles pour produire du lait et assurer les gains des veaux malgré les effets climatiques de chaque année. 266 données de brebis allaitantes, gestantes ou taries ont été enregistrés pendant trois ans. Les brebis allaitantes ont présenté les pertes de poids les plus fortes (–7,1 kg en trois mois). Les brebis gestantes et les brebis taries ont elles aussi perdu du poids (4 kg). Les causes plus probables de ces performances faibles sont la faible qualité de l'herbe (6,7 MJ EM/kg MS) et les coûts énergétiques liés aux déplacements quotidiens (longues distances et dénivelé important).*

***Mots-clés :** Vaches allaitantes, brebis, systèmes de production en montagne, pâturage d'été.*

Introduction

In mountain areas the foraging resources are quite heterogeneous, and thus they have been specialised either for providing preserved forages for the winter or to be grazed. The structure and possible use in time of the different grazable areas are the main factors conditioning animal management in these production systems (Revilla, 1987).

Most of the grazing season is spent on high mountain ranges during the summer, when private herds and flocks are joined into collective ones and graze together on these communal pastures (Manrique *et al.*, 1992).

Summer grazing has traditionally been considered as a period of high herbage availability in which the animals can certainly recover the body reserves mobilised during the winter housing period. However, when the seasonality of summer herbage production in the high mountain pastures was taken into account, it was proved to be a factor limiting the stocking rates which were possible in each area (Revilla, 1987), which set some doubts on the commonly admitted weight gains on these pastures. In fact recent studies in these conditions report losses of weight and body condition of ewes during the summer (Revilla *et al.*, 1991; Oregui *et al.*, 1994).

In order to clarify the role of summer grazing in the global operation of Pyrenean farming systems, the aim of this work was to study the evolution of weight and body condition score during this period in both sheep and cattle from an experimental farm. The effects of breed and physiological stage on these performances were also assessed.

Material and methods

The study was carried out at "La Garcipollera" research station, in the Spanish side of the Central Pyrenees.

The mountain ranges used during the summer were 1500-2200 m a.s.l., above *Pinus sylvestris* forests and with slopes ranging from 14 to 56% (Villalba *et al.*, 1995). These pastures were communities dominated by *Nardus stricta* and *Festuca skia*, and were similar to other high mountain pastures described in the Pyrenees, both in terms of botanical composition and also in herbage quality (Ascaso *et al.*, 1991; Aldezábal *et al.*, 1992). Though forage production and quality can vary widely in different areas of the range, these authors described forage yields from 1900 to 3600 kg dry matter (DM) per hectare, with an average forage quality of 0.5 UFL/kg DM.

Summers in these conditions are generally short, hot and dry. The average monthly temperatures and cumulative rainfall during the summer in the period of study (1988-1994) were 17.9°C and 271 l/m^2, respectively.

The available surface for cattle was about 800 ha, and the pastures for the sheep flock were about 1200 ha, although both species overlapped in some areas. Both sheep and cattle grazed on these pastures for about 100 days, all years pooled.

The animals used in the current study were Parda Alpina and Pirenaica cattle and Churra Tensina sheep.

Part of the cattle calved in spring (average calving date 15th March), and were thus lactating in the summer, and part calved in the autumn (average calving date 15th October), consequently being pregnant during the summer.

Data from the cattle herd were recorded over a seven-year period, from 1988 to 1994. The data set consisted of live weights at the beginning and the end of the summer grazing period of 534 spring-calving cows (307 Parda Alpina and 227 Pirenaica cows), 405 spring-born calves and 285 autumn-calving Parda Alpina cows.

The actual weights were transformed for analysis in order to minimise changes in live weight due to factors other than variations in body reserves. In the case of spring-calving cows that started summer grazing right after the housing period a reduction of 6% live weight was considered to account for changes in gut fill content due to turnout (INRA, 1978). The live weights of autumn-calving cows were corrected by conceptus weight, as a function of calving date and birth weight of the calf (INRA, 1978). There was no adjustment for gut fill change in autumn-calving cows because they had already been grazing for about two months during the spring (Ferrer *et al.*, 1998).

The reproductive management of the sheep flock was based on one lambing per year, with a main lambing season in spring (average lambing date 1st April), and a secondary one in the autumn (average lambing date 15th November). Spring-born lambs were reared on pasture with their dams up to 2.5 months and sold in mid June, except for the replacement female lambs, who went up to the summer ranges with their dams. Thus the ewes could be in three different physiological stages: lactating, non-lactating but pregnant and non-lactating, non-pregnant. Parity ranged from first to third in the three years of study.

All the sheep data were collected in the period 1993-1995. The experimental flock, of about 100 ewes, grazed together with a commercial one of 650 ewes, and the animals were unherded.

Sheep live weight and body condition on a 1 to 5 scale were recorded at the start and end of the summer. Live weight of pregnant sheep at the end of the summer was corrected by foetus and conceptus weight (Thériez *et al.*, 1987).

During the summer of 1994 (from 6 June to 10 September) the patterns of space use and feeding behaviour of sheep and cows on these mountain ranges were studied. Activity (grazing, walking or resting), biting rate and geographical position of the animals were recorded during daylight (5:00-23:00 h) every 30 minutes on six days at fortnightly intervals. This summer was particularly dry: the cumulative rainfall was 177.6 l/m^2, of which 41.1 were collected from June till August and 136.5 in September.

Herbage samples were also collected by hand-plucking at fortnightly intervals from July till September for chemical analysis and determination of energy content.

Results

Cattle performance

Cow weight changes during summer differed much over the years when actual, non-transformed cow live weights were analysed, from 40 kg gained (1988) to 20 kg lost (1993). After the transformations described above were conducted, weight changes ranged from +10.7 to +59.0 kg.

Performance of the spring-calving herd

For spring-calving cows, the average weight change was +30 kg (s.e. 1.1), which means an average daily gain of +0.3 kg/day (s.e. 0.01) (Table 1). Breed did not show any significant effect on total weight change or average daily gain of cows, while year, parity, physiological stage and initial weight were highly significant.

Table 1. Live weight change during summer grazing of Pirenaica and Parda Alpina spring-calving cows and their calves, and Parda Alpina autumn-calving cows (1988-1994). Mean (standard error)

Calving season	Spring		Autumn
Breed	Parda Alpina	Pirenaica	Parda Alpina
Grazing days	100	100	93
n	307	227	285
Cows			
Initial weight[†]	507.6 (2.65)	520.3 (3.14)	551 (3.11)
Weight gain[††]	28.2 (1.51)	32.1 (1.54)	39 (0.32)
Average daily gain	0.28 (0.01)	0.32 (0.02)	0.43 (0.02)
Calves			
Initial weight	121.6 (1.80)	114.7 (1.46)	–
Final weight	195.7 (1.92)	185.8 (1.85)	–
Average daily gain	0.94 (0.01)	0.9 (0.01)	–

[†] Corrected live weight at turnout for spring-calving cows.
[††] Net liveweight change, without conceptus weight, for autumn-calving cows.

The gains of multiparous cows were higher than those of primiparous ones, and non-lactating cows had higher gains than lactating ones. Gains and initial weights were inversely related ($p<0.01$), so that the lighter cows at the beginning of the summer were able to compensate their previous losses with higher gains.

Spring-born calves had high daily gains, 0.92 kg/day (s.e. 0.011), which were significantly affected by breed, calving order of the dam and calf weight at turnout. Parda Alpina calves had higher gains, although the magnitude of the difference between both breeds was quite variable in the different years. The heavier calves at the start of the grazing period had lower gains, and male calves were 5-7% heavier than females. Unlike cow performance, calf gains were very consistent through the years, ranging from 0.80 to 1.09 kg/day.

Performance of the autumn-calving herd

Autumn-calving cows always gained weight at pasture (+39.2 kg, s.e. 1.78), and these gains were quite constant over the seven years, ranging from 34 to 47 kg, that is +0.43 kg/day (s.e. 0.019) (Table 1). Neither year nor parity, physiological stage (pregnant or not) or initial weight had any effect on summer gains. Weight changes were only affected by calving date ($p<0.001$), with a linear effect so that cows in late pregnancy had lower gains than those calving later in the season (15 September-15 December).

Grazing behaviour

During the summer of 1994, the average stocking rate on the whole range was 0.20 cows/ha, but the animals only grazed on 12% of the available area, that is, about 100 ha of the 800-ha range. The use of space was highly related to the slope of the site and the distance between the site and water and salt points. The cows used three night resting areas near the water points and in the higher sites of the range.

Average daily grazing, resting and walking time are described in Table 2. Grazing activity showed the typical bimodal distribution during the day (Arnold and Dudzinski, 1978) (Fig. 1), the first grazing period starting between 5:30 h and 9:30 h and the second one between 13:00 h and 16:30 h. Biting rate was similar for cows of both breeds, 48.1 bites/minute (s.e. 2.76). Horizontal and vertical average and extreme distances travelled daily are shown in Table 3.

Table 2. Grazing, resting and walking time (hours/day) of sheep and cattle on the summer ranges during the summer of 1994. Mean$_{(standard\ error)}$

	Grazing time	Resting time	Walking time
Cattle	8.23 (0.26)	8.35 (1.24)	0.67 (0.21)
Sheep	7.06 (0.42)	8.7 (0.45)	1.84 (0.23)

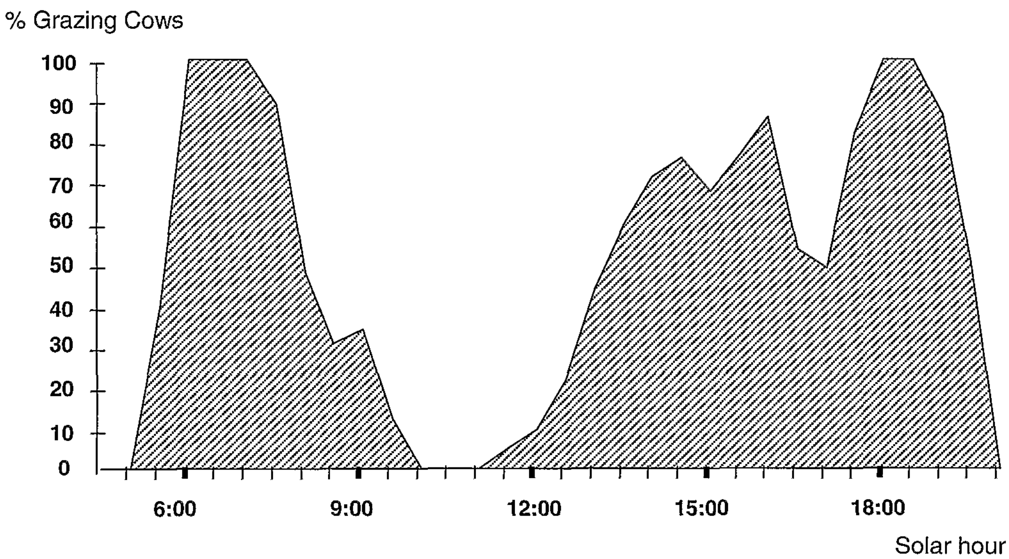

Fig. 1. Daily pattern of behaviour of the cattle herd.

Table 3. Horizontal and vertical distances travelled daily by sheep and cattle on the summer ranges during the summer of 1994

	Horizontal movements			Vertical movements		
	Average	Maximum	Minimum	Average	Maximum	Minimum
Cattle	1689	3783	246	278	640	0
Sheep	6150	12700	4100	659	1350	530

Sheep performance

Sheep in all physiological stages lost both weight and body condition score during the summer, the average loss being 4.54 kg and 0.78 points of BCS. Variation between years ranged from –5.4 kg to –2.9 kg (Table 4).

Table 4. Weight and body condition score (BCS) of ewes at beginning of the summer, and change during summer grazing. Mean$_{(\text{standard error})}$

Effect	No. animals	Initial weight	Weight change	Initial BCS	BCS change
Year					
1993	70	43 (0.49)	–5.4 (0.35)	3.35(0.05)	–0.82 (0.04)
1994	97	48 (0.60)	–5.3 (0.40)	4.36(0.06)	–1.05 (0.05)
1995	99	46 (0.52)	–2.9 (0.38)	2.98(0.06)	–0.48 (0.06)
Lambing order					
First	126	43 (0.34)	–3.7 (0.33)	3.56(0.04)	–0.90 (0.03)
Second or more	140	49 (0.43)	–5.1 (0.32)	3.60(0.09)	–0.68 (0.05)
Physiological stage					
Pregnant	56	45 (0.78)	–0.9 (0.47)	4.20(0.08)	–1.19 (0.05)
Lactating	76	47 (0.60)	–7.1 (0.37)	3.43(0.09)	–0.81 (0.05)
Dry, non-pregnant	134	46 (0.48)	–4.4 (0.26)	3.41(0.07)	–0.59 (0.05)

Lactating sheep showed the highest weight and BCS loss: 7.14 kg (close to 15% of their initial live weight) and 0.8 points BCS. Even dry, non-pregnant sheep lost around 4 kg of weight and 0.6 points of BCS.

The weight loss of pregnant ewes was lower, only 0.95 kg, however their BCS loss was higher than that of the other groups (1.19 points). When weight change was corrected by conceptus weight at the end of the summer they had also lost 4 kg, which is equal to the loss observed in dry, non-pregnant ewes.

First lambing ewes showed a lower loss of weight than older ewes (3.7 vs. 5.1 kg), as they were only 18 months old and thus still growing, but they lost more body condition than the others (0.90 vs. 0.68 points of BCS) (Table 4).

The initial BCS affected the subsequent BCS change, so that the loss of BCS was higher when the initial BCS was higher. Initial weight also affected weight variation in the same sense.

Sheep grazing behaviour

The flock used the surface of the summer range only partially, and most of the grazing activity was recorded between 1850 and 2200 m. From the whole 1200-ha range, only 450 ha were grazed:

considering the whole 750 sheep flock the stocking rate on the 450 ha actually used averaged 1.7 sheep/ha, but it would be lowered to 0.6 sheep/ha if the whole range was considered.

Sheep and cattle present in the same range grazed two different areas: ewes grazed mainly on higher areas whilst lower zones were used by cows.

Daily grazing journeys were very similar throughout the summer, with fixed night-resting places in the highest zone of range and variable day-resting places. Horizontal and vertical average and extreme distances travelled daily are shown in Table 3.

Daily grazing, resting and walking time are shown in Table 2. Grazing began at dawn and was divided into two periods, one in the morning and the other in the evening with a long resting time between them due to the high temperature.

Average biting rate was 40.7 bites/minute (s.e. 1.59), and it increased as the season progressed from 36 (s.e. 4.16) to 46 (s.e. 2.64) bites/minute. Within controls a significant effect of time in the day was observed, showing a higher biting rate in the evening than in the morning.

Discussion

Cattle performance

The gains of spring-calving cows grazing on these pastures during 3 months were moderate, in fact close to null if the adjustments for gut-fill change had not been considered, and with a wide between-year variation. Considering that from weaning to housing cows can hardly maintain their weight during autumn grazing (Casasús *et al.*, 1996), these gains are certainly far from those reported in temperate areas of Central Europe, where cows can gain up to 70-90 kg at pasture (Jarrige, 1974; Petit *et al.*, 1992), or in British conditions, where Wright *et al.* (1994) describe gains of 0.5 kg/day during a 5-month lactation period. However, they were similar to those achieved in other Spanish mountain areas, where gains of lactating cows during the summer ranged from –0.16 to +0.24 kg/day (Osoro *et al.*, 1995).

The higher gains of Parda Alpina calves can be due to the higher milk yield of their dams, which may also account for the different gains of calves from multiparous and primiparous cows (Blasco *et al.*, 1992; Villalba *et al.*, 1997). The fact that the heavier calves at the beginning of the summer had lower gains was likely to be an indirect effect of age: older calves are more dependent on herbage rather than milk, as their dams are in a later stage of lactation (Bailey and Lawson, 1981), but pasture allows for lower gains than milk (Le Du and Baker, 1979; Wright and Russel, 1987).

Calves had high and constant weight gains over the different years, which reflects the considerable ability of suckler cows to buffer calf growth on poor quality pasture such as the one presented in this study (6.7 MJ EM/kg DM), even in late lactation, which has also been described by other authors (Wright and Russel, 1987; McCall *et al.*, 1988). It seems that the effects of between-year climatic variations operated mainly on the dams' gains, while they were still able to provide enough milk for adequate calf growth, unaffected by the year.

Higher and more constant gains were achieved by autumn-calving cows, which were pregnant and non-lactating during the summer, and had thus less energy requirements. In fact, the management system under which these cows are conducted is based on the dissociation in time of the main energy-demanding metabolic functions: lactation and mating occur during the housing period, while the recovery of reserves in the dry period is left alone for the grazing season (Revilla, 1997), so that most of the ingested energy can be diverted into weight gain.

The gains of autumn-calving cows were only influenced by calving date, as in late pregnancy more energy is diverted to foetal growth, and consequently less energy is available for dam's gains. Initial weight had no effect on summer gains because the compensation of the performances obtained during the winter had already occurred during spring grazing on forest pastures (Ferrer *et al.*, 1998).

Sheep performance

At any physiological stage, sheep lost a considerable amount of reserves during summer grazing, although it was quite different each year, which could be due to previous management or climatic effects affecting animal performance directly or through pasture production.

Loss of body reserves on summer ranges has also been reported by other authors. Even in Central France, Molénat and Jarrige (1978) found weight losses between 2.9 and 9.5 kg when sheep grazed hill areas. Revilla *et al.* (1991) studied BCS evolution in three commercial Pyrenean farms during three years and found BCS losses between 0.34 and 0.46 points. In the Basque Pyrenees the summer is also defined as the most nutritionally restrictive season in the whole annual cycle (Oregui *et al.*, 1994).

On the opposite, other works developed in the French Pyrenees and the Alps showed results which are conflicting with ours. In fact, they are not comparable, because they include the variation of BCS between early spring and late autumn (Dedieu *et al.*, 1991; Molénat *et al.*, 1993). Taking into account the heterogeneity of herbage allowance and quality in time (Revilla, 1987), it is clear that although in spring and early summer there can be weight gains, late summer may be very restrictive and lead to a considerable loss of reserves.

When the first and second part of summer were analysed separately clear differences in the evolution of reserves were found (Blanch *et al.*, 1995; Marijuán and Oregui, 1996). Actually, in our study the analysis of the herbage samples collected at fortnightly intervals showed that the average quality was low [crude protein (CP): 8.02%; neutral detergent fibre (NDF): 62.7%; DM Digestibility: 50.8%], with a metabolizable energy (ME) content of only 6.7 MJ ME/kg DM, and that it decreased as the summer progressed, fibre content increasing while CP content and DM digestibility decreased markedly.

Grazing behaviour

The space was not homogeneously grazed by either sheep or cattle, and the stocking rates were low but similar to those reported by Revilla and Manrique (1980) in similar pastures. As described in other studies the use of space was highly related to altitude, slope, distance to water and salt points (Favre, 1978; Leclerc and Lecrivain, 1979; Pinchak *et al.*, 1991; Warren and Mysterud, 1991).

The preference of the animals to rest at night at the highest sites of the range and long displacements to the salt and water points could explain the long distances travelled daily. This led to an increase in energy requirements, which was 16% above maintenance for cattle (Villalba *et al.*, 1995) and up to 35% for sheep (Blanch *et al.*, 1995).

Although animals can compensate for low herbage allowance by increasing biting rate and grazing time (Hodgson, 1982; Milne, 1994), biting rate and grazing time in our study in either cattle or sheep were not as high as those reported in other works, which could mean that dry matter intake was not likely to be limited by herbage allowance in the range.

Estimation of herbage intake

Herbage intake of sheep and cattle in all physiological stages was estimated by calculating the energy intake necessary for the achieved performances (maintenance, weight gains, estimated milk production (Blasco *et al.*, 1992) and activity requirements) using ARC (1980) equations, and dividing then the energy intake by the average herbage energy content (6.7 MJ ME/kg DM).

Estimated herbage intake of autumn- and spring-calving cows was 14.7 and 15 kg DM/day respectively, values which are similar to the 14.74 kg DM/day recorded by Oliván (1995) using the n-alkane technique with Asturiana cattle in similar mountain grassland communities. This estimated daily intake is higher than that recorded indoors on a medium-quality hay diet (Revilla *et al.*, 1995). It seems that these animals could have been able to compensate for the low herbage quality with a high intake in order to cover their nutrient requirements, which could probably not be improved.

In the case of sheep, the total energy requirements for the whole summer were 774 MJ of ME for non-lactating ewes and 970 MJ of ME for lactating ones. Taking into account the observed herbage quality, the only way of avoiding weight loss would have been by achieving higher herbage intakes than the actually estimated: 1.4 kg DM/day in the case of non-lactating ewes and up to 1.7 kg DM/day for lactating sheep. These values are higher than the 1.13 kg DM/day observed when the voluntary intake of hay of a similar quality was measured. Thus, even expressing their maximum intake capacity the sheep would not have covered their requirements at such low herbage energy content. The increase in bite rate and grazing time throughout the summer reflects the effort of the ewes to increase herbage intake, although they could not achieve the necessary energy intake to cover their requirements from these pastures.

Conclusions

These results suggest that the most important cause of the low performances registered in both sheep and cattle during the summer was the very low herbage quality in these ranges, together with the high energy requirements associated to the use of these pastures. In fact, even in Central European conditions Petit *et al.* (1992) suggest that cows should be allowed to replenish their reserves at the beginning of the grazing season, before herbage availability or quality become limiting.

The different management practices that can be carried out during the rest of the year have to take into consideration that the recovery of reserves during the summer grazing period is limited in mountain conditions, as has been described in other works (Russel and Broadbent, 1985; Osoro *et al.*, 1995).

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