Factors affecting animal performance during the grazing season in a mountain cattle production system

I. Casasús, A. Sanz, D. Villalba, R. Ferrer, and R. Revilla

Departamento de Producción Animal, Servicio de Investigación Agroalimentaria, Diputación General de Aragón, 50080 Zaragoza, Spain

ABSTRACT: The factors influencing weight changes during the grazing season of Brown Swiss autumn-calving cows and Brown Swiss and Pirenaica spring-calving cows and their calves were studied over an 8-yr period in Spanish mountain conditions. The data set comprised 552 annual production cycles of cows that calved in two consecutive years. The animals grazed on alpine ranges during the summer and on forest pastures in the spring and autumn. They were housed during the winter and fed at different feeding levels (83 to 117% of their energy requirements) throughout the years of study. Weights were recorded every 3 mo and corrected to account for changes of digestive content and fetal growth, using theoretical relationships. Cow weight gains both on forest pastures and high mountain ranges were higher in autumn- than in spring-calving Brown Swiss cows, and therefore also during the whole grazing season (52.1 vs 7.7 kg, respectively, \( P < 0.001 \)). Therefore, weight at calving and thereafter was significantly higher in autumn- than in spring-calving cows, which was associated with better reproductive performance (35.5 vs 49.1 d from calving to first ovulation, \( P < 0.01 \)). In the spring-calving herd, Pirenaica cows had slightly higher gains than Brown Swiss cows during the grazing period (18.5 vs 7.7 kg, \( P < 0.001 \)), mainly due to their higher gains on forest pastures, but their reproductive performance was similar (44.5 vs 49.1 d from calving to first ovulation, respectively, not statistically significant). Gains were higher in multiparous than in primiparous cows (31.1 vs 14.1 kg, respectively, \( P < 0.001 \)), especially in the case of Brown Swiss cows, which were younger at first calving. Gains were affected by year of study (\( P < 0.001 \)) and previous weight changes during the housing period (\( r = -0.35 \) and \( r = -0.21 \) in autumn- and spring-calving cows respectively, \( P < 0.001 \)). In the case of autumn-calving cows, performance on pasture was also affected by the stage of pregnancy at housing (\( r = -0.51, P < 0.001 \)). Growth rates through lactation were higher in autumn- than in spring-born calves (\( P < 0.001 \)), although the shorter lactation period resulted in lower weight at weaning of the former (\( P < 0.001 \)). Breed was a significant source of variation in the performance of spring-born calves, weights and gains being higher in Brown Swiss than in Pirenaica calves (\( P < 0.001 \)).

Key Words: Beef Cows, Breeds, Calving Season, Mountain Pastures, Animal Performance

Introduction

The management of suckler cattle in European mountain conditions is based on long winter housing phases, imposed by the climatic conditions, when the generally restrictive nutrition levels lead to the mobilization of body reserves to maintain production. The adaptation of production systems to these harsh environments can be attained by the choice of calving and weaning dates and also by the use of breeds that are sufficiently adapted to such conditions (Thériez et al., 1994).

Calving in the spring has been recommended in mountain areas in order to synchronize maximum requirements with the period of higher herbage availability and quality (Jarrige, 1974). In these conditions, spring calving can reduce feeding costs (May et al., 1999) and increase bioeconomic efficiency (Pang et al., 1999). Calving in the autumn has been described as more adequate for areas with higher preserved forage availability, with short winters and dry summers (Giraud et al., 1987).

Pirenaica and Brown Swiss are two of the breeds more widespread in the Spanish Pyrenees, both managed as suckler cattle.


1The authors wish to thank the farm staff working at La Garcipollera Research Station and J. W. Holloway for helpful comments on the manuscript. Research funded by the projects CE DG VI-8001 CT 90.0002, CE DG VI-1124, INTERREG II and INIA 94-72. Students in receipt of grants from INIA and the Basque Government.

2Correspondence: P.O. Box 727 (phone: 34.976.716459; fax: 34.976.716335; E-mail: icasus@aragob.es).

3Current address: Departamento de Producción Animal, Universitat de Lleida, Avda. Rovira Roure 177, 25006 Lleida, Spain.

Received November 5, 1999.
Accepted January 17, 2002.
Mature weight is very similar in both breeds, around 575 kg at calving. The main differences between them have been found in aspects related to milk production; Brown Swiss cows have higher yields (Blasco et al., 1992) and their calves grow faster through weaning (Villalba et al., 2000). Also, Brown Swiss heifers reach puberty at similar weight but younger age than Pirenaica heifers, due to a faster maturing rate (Revilla et al., 1992a).

Several authors have reported breed differences in animal performance on pasture (Wright et al., 1994; D’Hour et al., 1995), but Brown Swiss and Pirenaica cattle have not yet been compared on these terms.

The objectives of this study were to determine the grazing performance of cows and calves of two different breeds and calving seasons in Spanish mountain production systems and establish the animal and management factors that affect this performance.

Materials and Methods

Data for this study consisted of the performances observed during the grazing season in a suckler cattle herd. In order to describe the conditions allowing for the reproducibility of the system, only the data of cows that calved in two consecutive years were taken into account for this study. Nonpregnant cows were retained in the herd but their data were disregarded.

Data were obtained over 8 yr (1988 to 1996) from 215 different purebred Brown Swiss and Pirenaica cows. They were the progeny of 28 different BS bulls and 17 Pi bulls that had been selected in both cases for growth potential and ease of calving and were representative of the breed and registered in the herdbook. Parity ranged from first to ninth calving, the proportion of primiparous cows in the herd being similar in the different years, and on average cows were in their third production year.

Study Site

Data were collected at La Garcipollera Research Station, in the mountain area of the central Pyrenees (Spain, 42°37’N, 0°30’W). The experimental site ranged in altitude from 950 to 2,200 m above sea level. The average annual rainfall during the period of study (1988 to 1996) was 999 mm, bimodally distributed with peaks in the spring and autumn, with dry summers and some precipitation in the form of snow in the winter. The mean annual temperature was 10.9°C. The temperature and precipitation patterns throughout the year in the period of study are shown in Figure 1.

Soils on the study site were mainly Flysch (a sequence of sediments comprising sandstones, conglomerates, marls, shales and clays), in contact with a karstic land of limestones in the northern part of the area.

Two main vegetation types can be differentiated in the study area. The lower part of the range (900 to 1,500 m altitude) consisted of 1,500-ha forest pastures, reafforested with Pinus nigra, with bushes of Buxus sempervirens, Juniperus communis, and Genista scorpius. Herbaceous cover on these pastures was 38% on average, ranging from 15.9 to 89.9% in the different botanical communities (Garín, 1997). Brachypodium spp., Bromus erectus, Festuca rubra, Carex spp., and Aphyllanthes monspeliensis were the predominant grass species. Average herbage availability on these pastures over several years was 741 kg DM/ha (8.2% CP, 75.3% NDF), with peak production and higher quality at the end of the spring (Garín, 1997). These pastures were used during the spring and autumn by groups of about 50 cows, at a stocking rate of 0.03 cows/ha, but cows only used 16% of the available surface (250 ha, at 0.2 cows/ha) (Revilla et al., 1995).

The upper supraforestal pastures (1,500 to 2,200 m) consisted of an 800-ha range where vegetation was dominated by grass, mainly Festuca rubra, Festuca skia, Bromus erectus, Nardus stricta, and Trifolium alpinum. Although herbage mass was higher in these pastures (from 1,900 to 4,100 kg DM/ha in the different areas), quality was also low (7.4% CP, 65.3% NDF) (Villalba et al., 1995). Pasture size was 800 ha, and slopes ranged from 15 to 55%. These pastures were used by about 120 cows and 50 calves each year, but of the 800 ha available animals were only observed to graze on 100 ha (13%) (Villalba et al., 1995).

Animal Management

According to reproductive management, the herd was divided into two groups. The first included both Brown Swiss and Pirenaica cows that calved in the spring, which is the traditional management in the Pyrenean area, and the other one consisted of only Brown Swiss cows calving in the autumn, a practice which is becoming increasingly common.

Spring-calving cows of both breeds calved from February 15 to May 15. They were housed in a loose-housing system from mid-December until June 15, that is, during late pregnancy and the first months of lactation. During the summer the dams and their calves grazed on the high mountain pastures described above, until...
weaning on September 15, when calves were on average 6 mo old. Then the nonlactating, pregnant cows grazed on forest pastures until December 15. The average length of the grazing season was 183 d.

Autumn-calving Brown Swiss cows calved from September 15 to December 15. They were housed throughout lactation, from the start of the calving season till approximately April 15, the date of turnout depending on weather conditions. Their calves were weaned by mid-March at 4.5 mo of age on average and were not turned out to pasture, but were sold directly. The dry, pregnant cows grazed for about two months (April 15 to June 15) on forest pastures. During the summer (June 15 to September 15), they grazed together with the spring-calving herd on high mountain ranges, and then they were housed again in the autumn. In this case, the grazing season averaged 158 d.

In both cases cows were bred by natural service to bulls of their same breeds during a 3-mo breeding season, May 15 to August 15 for spring-calving cows and December 15 to March 15 for autumn-calving ones. Sires were randomly assigned among cows.

During the winter housing period the cows were group-fed and received different feedstuffs, of which samples were taken throughout the indoor period for chemical analysis. These regimens were homogeneous within years, although forage quality varied between years. The feeds used from 1988 to 1994 were hay from natural polyphylet meadows (mainly Festuca arundinacea, Trifolium repens, Poa pratensis and Dactylis glomerata, 10.7% CP, 8.5% MJ ME/kg DM, on average), alfalfa hay (17.4% CP, 8.7 MJ ME/kg DM), barley straw (4.4% CP, 6.3 MJ ME/kg DM), and rolled barley grains (12.1% CP, 12.9 MJ ME/kg DM). In the last 2 yr, cows received total mixed rations that were commercial mixtures of alfalfa hay, barley straw, barley grains, alfalfa pellets, orange pulp, and molasses (9.6% CP, 9.0 MJ ME/kg DM).

Cows were fed at a wide range of feeding levels during the period of study, with the double objective of studying the effects of different planes of nutrition on animal performance and reproductive rates during the housing period (Blasco, 1991; San Juan, 1993; Sanz, 2000) and also to create different animal conditions at turnout to study their effect on performance on pasture.

According to ME requirements for maintenance and production (ARC, 1980), spring-calving cows were fed on average at 100% (annual means ranging from 89% to 112%) of their requirements during the prepartum phase, in the first half of the housing period, and then, during the postpartum indoor period, the average feeding level was 105% of their ME needs (87 to 117%). Brown Swiss and Pirenaica cows received the same amounts of food throughout the housing period. In the autumn-calving herd, feeding levels during lactation were on average 95% of animal requirements, ranging from 83% to 110%. Body condition score at turnout as assessed on a 5-point scale (1 = thinnest, 5 = fattest; Lowman et al., 1976) was 2.5 points on average for both calving seasons, with a coefficient of variation of 15% depending on the nutritional treatments applied during the housing phase both within and between years, annual means per calving season, and feeding levels ranging from 2.27 to 2.77 (Villalba, unpublished data). Calves did not receive any concentrates in the lactation period in either calving season.

The data set consisted of 196 annual production cycles of Brown Swiss autumn-calving cows, 176 cycles of Brown Swiss spring-calving cows, and 180 cycles of Pirenaica spring-calving cows and their calves. Twenty-five percent of these data belonged to primiparous cows, homogeneously distributed among the years according to the target annual replacement rate of 20 to 25% through the period of study.

Due to their higher sexual precocity (Olleta et al., 1993) and the lack of negative effects of having Brown Swiss heifers calving for the first time at 2.5 yr of age (Revilla et al., 1992b), Brown Swiss heifers were systematically mated at 20 to 22 mo of age, so that first calving occurred at 2.5 yr of age, whereas Pirenaica heifers were mated at 26 to 28 mo of age and calved for the first time when they were 3.0 yr old. Number of cows per breed, calving season, and year are shown in Table 1.

Data Collection

The animals were weighed on two consecutive days at calving and at 3-mo intervals throughout the year, whenever changes of management occurred (turnout, housing, movement from forest pastures to high mountain ranges, and vice versa). Cows and calves were also weighed at 2-wk intervals through the housing period.

The aim of the study was to analyze changes of weight independent of those related to pregnancy or to changes in digestive content. Therefore, some corrections were made on the actually registered live weights. At turnout, the loss of digestive content due to the change from a dry to a green diet was considered to be 6% of live weight (INRA, 1978). This figure was provided for cows changing from hay diets to green pasture, and it was close to the range of 6.5 to 7.5% reported by Ferrer et al. (1997) in two experiments in which animals were turned out to forest pastures.

The estimated weight of the gravid uterus was subtracted from the live weights of pregnant cows, based on the following relationship (INRA, 1978):

$$ MW = LW - Wgu = LW - \left[ e^{-6.43 + 1.728 \times \ln(t) + \frac{CW}{57.8}} \right] - (2.43) + (CW \times e^{2.748(1 - e^{-0.00487(t/296 - 1)})}) $$

where MW = maternal weight, LW = live weight, Wgu = weight of the gravid uterus, CW = calf birth weight, and t = day of pregnancy.

The data considered for the study were the corrected weight gains obtained on forest pastures, on high moun-
tain ranges, and during the whole grazing period by cows of both breeds and calving seasons. Although factors influencing calf performance in these conditions have been thoroughly described and discussed by Villalba et al. (2000), the weights and gains of the offspring of the cows involved in the present study were also analyzed. Average daily gains (ADG) in each period were calculated as the difference between initial and final weight divided by the length of the period.

**Data Analysis**

The original data set comprised 552 production cycles of Brown Swiss and Pirenaica primiparous and multiparous spring- and autumn-calving cows, with Pirenaica cows only calving in the spring, as has been described above.

The aim of the study was to determine the factors influencing weight gains during the grazing season in all types of cows, with particular emphasis on the effects of calving season and breed on animal performance on pasture. In order to achieve this objective, the original data set was divided into three subsets in which different analyses were performed using the SAS statistical package (SAS Inst. Inc., Cary, NC). A General Linear Models procedure with stepwise deletion of nonsignificant variables was used to test the different factors influencing animal weights and gains. The models tested in each subset are described below.

**Autumn-Calving Herd (Brown Swiss Cows) (Subset 1).** The first subset included the data of all autumn-calving cows (196 production cycles of Brown Swiss multiparous and primiparous cows). The analyses conducted on this data subset aimed at determining the factors influencing the weight gains of these cows throughout the grazing season.

Cow live and corrected weights during the production cycle, from calving to next calving, were analyzed testing the effects of year, parity (primiparous vs multiparous), and their interaction.

\[
\text{Weight}_{ijk} (\text{kg}) = \text{Year}_i + \text{Parity}_j + \text{Breed}_k \\
+ \text{Year} \times \text{Parity}_j + a \times \text{ADG} (\text{previous period})_{ij} \\
+ b \times \text{Initial weight}_{ij} + c \times \text{Day of pregnancy at housing}_{ij} + d \times \text{No. grazing days} + e_{ij} \quad [\text{model 2}]
\]

**Spring-Calving Herd (Brown Swiss and Pirenaica Cows) (Subset 2).** The second subset included the data of all spring-calving cows (356 production cycles of Brown Swiss and Pirenaica multiparous and primiparous cows). The objective of the analyses conducted on this data subset was to determine the factors influencing cow weight gains during the grazing season, particularly the effect of breed.

Cow live and corrected weights during the production cycle were analyzed testing the effects of year, parity (primiparous vs multiparous), breed (Brown Swiss vs Pirenaica), and their interactions:

\[
\text{Weight}_{ijk} (\text{kg}) = \text{Year}_i + \text{Parity}_j + \text{Breed}_k \\
+ \text{Year} \times \text{Parity}_j + \text{Year} \times \text{Breed}_k \\
+ \text{Parity} \times \text{Breed}_k + \text{Year} \times \text{Parity} \times \text{Breed}_k + a \times \text{age}_{ijk} + e_{ijk} \\
\quad [\text{model 3}]
\]

In the analysis of daily gains in a given period (whole grazing season, summer on high mountain ranges, and autumn on forest pastures) year, parity, breed, and their interactions were tested as main effects, and ADG in the previous period, cow initial weight, day of pregnancy at housing, and the number of grazing days were tested as covariates:

\[
\text{ADG (given period)}_{ijk} (\text{kg}) = \text{Year}_i + \text{Parity}_j + \text{Breed}_k \\
+ \text{Year} \times \text{Parity}_j + \text{Year} \times \text{Breed}_k \\
+ \text{Parity} \times \text{Breed}_k + \text{Year} \times \text{Parity} \times \text{Breed}_k \\
+ a \times \text{ADG (previous period)}_{ijk} + b \times \text{Initial weight}_{ijk} \\
+ c \times \text{Day of pregnancy at housing}_{ijk} \\
+ d \times \text{No. grazing days}_{ijk} + e_{ijk} \\
\quad [\text{model 5}]
\]

The factors influencing calf performance were analyzed using the following model, with four fixed levels of calving season and breed on animal performance on pasture. In order to achieve this objective, the original data subset was to determine the factors influencing calf performance in these conditions have been thoroughly described and discussed by Villalba et al. (2000), the weights and gains of the offspring of the cows involved in the present study were also analyzed. Average daily gains (ADG) in each period were calculated as the difference between initial and final weight divided by the length of the period.

**Table 1. Number of cows per breed, calving season, and year**

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<thead>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn</td>
<td>Brown Swiss</td>
<td>—</td>
<td>30</td>
<td>19</td>
<td>35</td>
<td>27</td>
<td>16</td>
<td>31</td>
<td>32</td>
<td>6</td>
<td>196</td>
</tr>
<tr>
<td>Spring</td>
<td>Brown Swiss</td>
<td>28</td>
<td>—</td>
<td>27</td>
<td>25</td>
<td>15</td>
<td>14</td>
<td>17</td>
<td>26</td>
<td>24</td>
<td>176</td>
</tr>
<tr>
<td>Spring</td>
<td>Pirenaica</td>
<td>13</td>
<td>—</td>
<td>24</td>
<td>20</td>
<td>12</td>
<td>23</td>
<td>28</td>
<td>38</td>
<td>38</td>
<td>180</td>
</tr>
</tbody>
</table>
(year, parity of the dam, sex, and breed) and their two-, three-, and four-way interactions, and a covariable (calf age):

\[ CW_{ijkl} = Year_i + Parity_j + Sex_k + Breedi*j*l 
+ Year_i * Parity_j + Year_i * Sex_k + Year_i * Breedi*j*l 
+ Sex_k * Breedi*j*l + Year_i * Parity_j + Sex_k * Breedi*j*l + Year_i * Breedi*j*l 
+ Parity_j * Sex_k + Parity_j * Breedi*j*l 
+ Sex_k * Breedi*j*l + Year_i * Parity_j + Sex_k * Breedi*j*l + Parity_j * Breedi*j*l 
+ Sex_k * Breedi*j*l + Year_i * Parity_j + Sex_k * Breedi*j*l + Parity_j * Breedi*j*l 
+ a_i * ageijkl + eijkl \]

[model 6]

**Multiparous Brown Swiss Spring and Autumn-Calving Cows (Subset 3).** A third data subset was built combining all data from Brown Swiss multiparous cows (275 production cycles of autumn- and spring-calving cows), with the objective of studying the particular effect of calving season on cow performance throughout the grazing season.

Cow live and corrected weight were analyzed testing the effects of year, calving season (autumn vs spring), and their interaction:

\[ Weight_{ij} (kg) = Year_i 
+ Calving season_j + [model 7] 
+ Year_i * Calving season_j + e_{ij} \]

When daily gains in a given period (whole grazing season, summer on high mountain ranges, and autumn or spring on forest pastures) were analyzed, year, calving season (autumn vs spring), and their interaction were tested as main effects, and the ADG in the previous period, cow initial weight, day of pregnancy at housing, and the number of grazing days were tested as covariates:

\[ ADG \text{ (given period)}_{ij} (kg) = Year_i + Calving season_j 
+ Year_i * Calving season_j + a_i * ADG \text{ (previous period)}_{ij} 
+ b_i * Initial weight_{ij} + c_i * Day of pregnancy at housing_{ij} 
+ d_i * No. grazing days_{ij} + e_{ij} \]

[model 8]

To test the effect of calving season on calf weights at birth and weaning and gains during the housing period, the following model was used on calves born from multiparous spring- and autumn-calving cows:

\[ CW \text{ or ADG}_{ijkl} (kg) = Year_i + Calving season_j 
+ Sex_k + Year_i * Calving season_j + Year_i * Sex_k + Sex_k * Calving season_j 
+ Year_i * Sex_k + Calving season_{i+j+k} + e_{ijkl} \]

[model 9]

Because the different models were unbalanced the least squares means could not be estimated in all cases, and results are presented as unadjusted means ± standard errors, together with the level of significance of the difference between the levels of the fixed effects, according to the models. When results were significant, comparisons were made using Tukey’s studentized range test procedure in the SAS package. Simple correlations between variables were conducted using PROC CORR (SAS Inst. Inc.).

**Results**

The unadjusted means of calving dates, calving intervals, live weights, and weights corrected for changes of digestive content and fetal growth of cows of both calving seasons, breeds, and parities are shown in Table 2. Within calving season, calving dates were affected by parity, because the animals were managed so that primiparous cows calved 1 to 2 wk earlier than the rest of the herd.

In the spring-calving herd, age at calving of primiparous cows differed significantly between breeds. As has been described above, Brown Swiss heifers had been mated at 20 to 22 mo of age and thus calved when they were 2.5 yr old, whereas Pirenaica heifers calved for the first time at 3.0 yr of age. Weight at calving was slightly higher in Pirenaica than in Brown Swiss primiparous cows, although the difference was not significant \(P > 0.10\). Therefore, in all the analyses presented here any breed × parity effect is confounded with the effect of age at first calving and will thus not be interpreted as an interaction.

Live weight at calving and thereafter was significantly higher in autumn- than in spring-calving cows and also in multiparous than in primiparous cows.

There were no breed effects on weight at calving of spring-calving cows. However, the higher weight loss of Brown Swiss cows during the early lactation period (225 vs 133 g/d, \(P < 0.001\)), due to their higher milk yield, led to breed differences in weight at turnout \(P < 0.001\). These effects persisted until the end of the grazing season, but then compensations occurred during the prepartum housing period, when cows of both breeds were fed at identical nutrition levels, as has been described in the Materials and Methods section, and thus weight at calving the year after was not different for both breeds.

The unadjusted means and standard errors of average daily gains of autumn-calving cows are presented in Table 3, and those of spring-calving cows are shown in Table 4.

Year was a significant source of variation in the analyses of weight gains in all the periods. There were significant interactions between year of study and parity and also between year and breed, reflecting that the magnitude of the difference in gains between breeds or parities, although always in the same sense, was not constant through the different years.

The weights and average daily gains of calves born from cows of both calving seasons, breeds, and parities are shown in Table 5.
Table 2. Live and corrected weights of primiparous and multiparous autumn- and spring-calving cows of both breeds throughout the annual cycle (unadjusted means ± SE)a

<table>
<thead>
<tr>
<th>Item</th>
<th>Calving season:</th>
<th>Parity:</th>
<th>Breed:</th>
<th>Level of significancec</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Autumn</td>
<td>Multiparous</td>
<td>B.S.</td>
<td>Parity (P)</td>
</tr>
<tr>
<td></td>
<td>Autumn</td>
<td>Primiparous</td>
<td>B.S.</td>
<td>Subsets 1 and 2</td>
</tr>
<tr>
<td>n</td>
<td>152</td>
<td>44</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>Calving date</td>
<td>29 Oct. ± 1.9</td>
<td>15 Oct. ± 3.9</td>
<td></td>
<td>14 Mar. ± 1.9</td>
</tr>
<tr>
<td>Calving interval, d</td>
<td>370 ± 1.8</td>
<td>370 ± 2.3</td>
<td></td>
<td>374 ± 3.0</td>
</tr>
<tr>
<td>Weight at calving, kg</td>
<td>599 ± 4.3</td>
<td>537 ± 7.8</td>
<td></td>
<td>574 ± 4.7</td>
</tr>
<tr>
<td>Corrected</td>
<td>533 ± 3.9</td>
<td>498 ± 6.0</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>Weight at start of spring grazing, kg</td>
<td>569 ± 4.2</td>
<td>533 ± 6.5</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>Corrected</td>
<td>533 ± 3.9</td>
<td>498 ± 6.0</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>Weight at start of summer grazing, kg</td>
<td>564 ± 3.8</td>
<td>527 ± 7.3</td>
<td></td>
<td>551 ± 4.1</td>
</tr>
<tr>
<td>Corrected</td>
<td>553 ± 3.7</td>
<td>515 ± 6.9</td>
<td></td>
<td>518 ± 3.8</td>
</tr>
<tr>
<td>Weight at end of summer grazing, kg</td>
<td>635 ± 4.0</td>
<td>588 ± 9.3</td>
<td></td>
<td>550 ± 3.7</td>
</tr>
<tr>
<td>Corrected</td>
<td>588 ± 3.9</td>
<td>539 ± 8.6</td>
<td></td>
<td>548 ± 3.7</td>
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<tr>
<td>Weight at end of autumn grazing, kg</td>
<td>608 ± 4.8</td>
<td>554 ± 7.4</td>
<td></td>
<td>568 ± 4.0</td>
</tr>
<tr>
<td>Corrected</td>
<td>608 ± 4.8</td>
<td>554 ± 7.4</td>
<td></td>
<td>568 ± 4.0</td>
</tr>
</tbody>
</table>

aCorrections accounted for changes of digestive content at turnout and weight of the gravid uterus of pregnant cows.

bB.S.: Brown Swiss; Pi: Pirenaica.

cResults from models [1], [4], and [7] tested on subsets of data 1, 2, and 3, respectively.

*P < 0.05.

***P < 0.001.
Autumn-Calving Herd

The gains of autumn-calving cows were positive and steady throughout the grazing season (Figure 2). Gains were significantly affected by year and parity of cows, so that multiparous cows always had higher gains than primiparous ones (Table 3). In the spring on forest pastures, ADG was negatively related to ADG during the lactation period indoors \((r = -0.35, P < 0.001)\). Although the average date of turnout was April 12, due to the different weather conditions in the years of study it ranged from March 20 in 1996 to April 23 in 1992. Gains during the spring were negatively correlated to date of turnout to pasture \((r = -0.50, P < 0.001)\), so that the later the turnout, the higher the daily gains, due to increasing herbage availability as spring advanced.

During the summer, ADG was negatively related to the ADG observed in spring \((r = -0.24, P < 0.001)\) and also to the day of pregnancy at housing \((r = -0.51, P < 0.001)\); the cows in a more advanced stage of gestation had lower maternal weight gains, although they had higher live weight gains due to fetal growth. The same effects were observed when the gains during the entire grazing season were considered. Gains in this period were affected by year \((P < 0.001)\) and parity \((P < 0.001)\), and also by gains during the lactation period indoors \((r = -0.34, P < 0.001)\), indicating that a compensation of previous performance occurred on pasture. The stage of pregnancy at housing also affected maternal weight gains on pasture \((r = -0.30, P < 0.001)\), and so did the length of the grazing season \((r = -0.23, P < 0.01)\), mainly due to the different dates of turnout in the spring. These factors accounted for 70% of the total variance in ADG in the grazing season. The mean ADG of 335 g/d led to average weight gains of 52.1 kg over the 158-d grazing season, ranging from 31 to 75 in the different years of the study, with a coefficient of variation of 28.3%.

Calves born from autumn-calving cows were housed during the whole lactation period. Their gains were only influenced by year of study and sex \((P < 0.001)\), male calves growing 63 g/d faster than females.

Spring-Calving Herd

After turnout, spring-calving cows had significant weight gains during the summer on high mountain ranges (Table 4). These gains did not differ between breeds and were higher in multiparous than in primiparous cows. The gains during the summer were negatively correlated with those observed during the lactation period indoors \((r = -0.23, P < 0.001)\). During the autumn on forest pastures, nonlactating, pregnant cows had live weight gains, due to fetal growth, but maternal weight losses (Figure 2). According to model [5], these daily losses were 151 g higher in Brown Swiss than in Pirenaica cows \((P < 0.001)\). In Pirenaica cows gains did not differ significantly between primiparous and multiparous cows in this period, but in the case of Brown Swiss the weight losses of primiparous cows were 108 g/d higher than those of multiparous cows \((P < 0.01)\). Gains were again negatively correlated with those observed in the previous period, on the summer ranges.

As a consequence of what was observed during the summer and autumn grazing periods, in the whole grazing season gains were influenced by year \((P < 0.001)\), parity \((P < 0.001)\), and breed \((P < 0.001)\). According to the model, daily gains were 69 g higher in multiparous than in primiparous cows, and the gains of Pirenaica cows were 106 g/d higher than those of Brown Swiss cows. There was, however, an interaction between breed and year, because although the gains of Pirenaica cows were always higher, this difference only reached significance in 1988, 1991, 1992, 1993, and 1995. Gains in the grazing season were also affected by weight at turnout \((r = -0.27, P < 0.001)\) and ADG during the postpartum period indoors, the first half of lactation \((r = -0.22, P < 0.001)\). These factors accounted for 45% of the total variance in ADG in the grazing season. The gains at pasture of spring-calving cows were only 76 g/d on average, which over 6 mo led to an average weight gain of 13.1 kg, although there was a wide variation between years, from an average loss of 10 kg in 1996 to a gain of 35 kg in 1992 (least squares means of the described models, CV = 93.9%). Brown Swiss spring-born calves were heavier at birth than Pirenaica ones \((P < 0.001)\), a difference that persisted until weaning at the end of the summer (Table 5). During the lactation period indoors they grew more quickly than Pirenaica calves \((P < 0.001)\), and they also tended to have higher gains during the summer grazing period, although the difference between breeds was

### Table 3. Average daily gains of primiparous and multiparous Brown Swiss autumn-calving cows throughout the grazing season (unadjusted means ± SE)

<table>
<thead>
<tr>
<th>Item</th>
<th>Multiparous</th>
<th>Primiparous</th>
<th>Level of significance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>152</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>ADG spring grazing on forest pastures, kg</td>
<td>0.433 ± 0.050b</td>
<td>0.280 ± 0.091c</td>
<td>***</td>
</tr>
<tr>
<td>ADG summer grazing on high mountain ranges, kg</td>
<td>0.375 ± 0.020b</td>
<td>0.262 ± 0.041c</td>
<td>***</td>
</tr>
<tr>
<td>ADG grazing season, kg</td>
<td>0.356 ± 0.015b</td>
<td>0.264 ± 0.035c</td>
<td>***</td>
</tr>
</tbody>
</table>

*Results from model 2 tested on subset 1.

Within a row, means with different superscripts are significantly different \((P < 0.05)\).

### Autumn-Calving Herd

The gains of autumn-calving cows were positive and steady throughout the grazing season (Figure 2). Gains were significantly affected by year and parity of cows, so that multiparous cows always had higher gains than primiparous ones (Table 3). In the spring on forest pastures, ADG was negatively related to ADG during the lactation period indoors \((r = -0.35, P < 0.001)\). Although the average date of turnout was April 12, due to the different weather conditions in the years of study it ranged from March 20 in 1996 to April 23 in 1992. Gains during the spring were negatively correlated to date of turnout to pasture \((r = -0.50, P < 0.001)\), so that the later the turnout, the higher the daily gains, due to increasing herbage availability as spring advanced.

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The mean ADG of 335 g/d led to average weight gains of 52.1 kg over the 158-d grazing season, ranging from 31 to 75 in the different years of the study, with a coefficient of variation of 28.3%.

Calves born from autumn-calving cows were housed during the whole lactation period. Their gains were only influenced by year of study and sex \((P < 0.001)\), male calves growing 63 g/d faster than females.

### Spring-Calving Herd

After turnout, spring-calving cows had significant weight gains during the summer on high mountain ranges (Table 4). These gains did not differ between breeds and were higher in multiparous than in primiparous cows. The gains during the summer were negatively correlated with those observed during the lactation period indoors \((r = -0.23, P < 0.001)\). During the autumn on forest pastures, nonlactating, pregnant cows had live weight gains, due to fetal growth, but maternal weight losses (Figure 2). According to model [5], these daily losses were 151 g higher in Brown Swiss than in Pirenaica cows \((P < 0.001)\). In Pirenaica cows gains did not differ significantly between primiparous and multiparous cows in this period, but in the case of Brown Swiss the weight losses of primiparous cows were 108 g/d higher than those of multiparous cows \((P < 0.01)\). Gains were again negatively correlated with those observed in the previous period, on the summer ranges.

As a consequence of what was observed during the summer and autumn grazing periods, in the whole grazing season gains were influenced by year \((P < 0.001)\), parity \((P < 0.001)\), and breed \((P < 0.001)\). According to the model, daily gains were 69 g higher in multiparous than in primiparous cows, and the gains of Pirenaica cows were 106 g/d higher than those of Brown Swiss cows. There was, however, an interaction between breed and year, because although the gains of Pirenaica cows were always higher, this difference only reached significance in 1988, 1991, 1992, 1993, and 1995. Gains in the grazing season were also affected by weight at turnout \((r = -0.27, P < 0.001)\) and ADG during the postpartum period indoors, the first half of lactation \((r = -0.22, P < 0.001)\). These factors accounted for 45% of the total variance in ADG in the grazing season.

The gains at pasture of spring-calving cows were only 76 g/d on average, which over 6 mo led to an average weight gain of 13.1 kg, although there was a wide variation between years, from an average loss of 10 kg in 1996 to a gain of 35 kg in 1992 (least squares means of the described models, CV = 93.9%).

Brown Swiss spring-born calves were heavier at birth than Pirenaica ones \((P < 0.001)\), a difference that persisted until weaning at the end of the summer (Table 5). During the lactation period indoors they grew more quickly than Pirenaica calves \((P < 0.001)\), and they also tended to have higher gains during the summer grazing period, although the difference between breeds was
Table 4. Average daily gains of primiparous and multiparous Brown Swiss (B.S.) and Pirenaica (Pi.) spring-calving cows throughout the grazing season (unadjusted means ± SE)

<table>
<thead>
<tr>
<th>Item</th>
<th>B.S. Multiparous</th>
<th>B.S. Primiparous</th>
<th>Pi. Multiparous</th>
<th>Pi. Primiparous</th>
<th>Level of significancea</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>123</td>
<td>53</td>
<td>141</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>ADG summer grazing on high mountain ranges, kg</td>
<td>0.321 ± 0.024b</td>
<td>0.105 ± 0.032c</td>
<td>0.333 ± 0.021b</td>
<td>0.135 ± 0.031c</td>
<td>NS</td>
</tr>
<tr>
<td>ADG autumn grazing on forest pastures, kg</td>
<td>-0.162 ± 0.026c</td>
<td>-0.270 ± 0.045d</td>
<td>-0.089 ± 0.023bc</td>
<td>-0.007 ± 0.046b</td>
<td>*** NS *** NS **</td>
</tr>
<tr>
<td>ADG grazing season, kg</td>
<td>0.076 ± 0.015c</td>
<td>-0.033 ± 0.024d</td>
<td>0.121 ± 0.016b</td>
<td>0.063 ± 0.025c</td>
<td>*** *** ***</td>
</tr>
</tbody>
</table>

aResults from model 5 tested on subset 2.

b,c,dWithin a row, means with different superscripts are significantly different (P < 0.05).

**P < 0.01.

***P < 0.001.

Table 5. Live weights (CW) and daily gains (ADG) of Brown Swiss and Pirenaica calves born from primiparous and multiparous autumn- and spring-calving cows (least squares means ± SE)a

<table>
<thead>
<tr>
<th>Item</th>
<th>Subset 1 (B.S. autumn-born calves)</th>
<th>Subset 2 (B.S. and Pi. spring-born calves)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parity of the dam</td>
<td>Sex</td>
<td>Significance</td>
</tr>
<tr>
<td>CW birth, kg</td>
<td>Multiparous</td>
<td>Primiparous</td>
<td>Males</td>
</tr>
<tr>
<td></td>
<td>43.6 ± 0.5</td>
<td>39.1 ± 0.9</td>
<td>42.6 ± 0.6</td>
</tr>
<tr>
<td>CW turnout, kg</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CW weaning, kg</td>
<td>161.9 ± 2.8</td>
<td>159 ± 6.2</td>
<td>164.6 ± 4.2</td>
</tr>
<tr>
<td>ADG housing, kg</td>
<td>0.913 ± 0.013</td>
<td>0.868 ± 0.030</td>
<td>0.922 ± 0.020</td>
</tr>
<tr>
<td>ADG grazing, kg</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

aResults from models 3 and 6 tested on subsets 1 and 2, respectively.

***P < 0.001.
smaller in the summer than during the housing period ($P = 0.12$). In both cases gains were affected by sex and parity of the dam ($P < 0.001$). Year of study was also a significant source of variation in all the analysis, which could in part be due to the fact that the individuals were not the same over the years, and individual variability can have a large effect on weights and gains (Villalba et al., 2000). The nutritional levels established during the housing period were not constant through the period of study, and even differed between groups of cows in a given year, which allowed a wide range of initial animal conditions to be tested in the different years. The effect of these planes of nutrition on grazing performance has already been tested in the models in the form of cow weight at turnout and daily gains during the housing period.

The weather conditions of each year and(or) other management, animal, or environmental factors may also have affected animal performance. When the gains in a given period were related to the rainfall accumulated either in that period or in the previous 3 mo, no relationship was observed in the spring-calving herd at any time, whereas in autumn-calving cows this relationship ranged from 0.25 to 0.35 ($P < 0.001$). However, when these variables were included in the models analyzing gains on pasture, they did not increase the $R^2$ of the equations, maybe because they were not related enough to forage quality and availability through the grazing season. In the conditions of this study, due to the steep slopes and unstable lithology, the form of precipitation may also have been important, because water coming very frequently in the form of storms is insufficiently retained in the soil and is thus less determinant of forage production.

Discussion

Many aspects related both to animal type and management have been identified as factors influencing animal performance during the grazing season. The factors influencing calf weights and preweaning gains have been described and thoroughly discussed by Villalba et al. (2000), who already observed higher weights and gains in autumn- vs spring-born calves, in those born from multiparous vs primiparous dams, and in Brown Swiss vs Pirenaica calves.

Year. Year was a significant source of variation in all the analysis, which could in part be due to the fact that the individuals were not the same over the years, and individual variability can have a large effect on weights and gains (Villalba et al., 2000). The nutritional levels established during the housing period were not constant through the period of study, and even differed between groups of cows in a given year, which allowed a wide range of initial animal conditions to be tested in the different years. The effect of these planes of nutrition on grazing performance has already been tested in the models in the form of cow weight at turnout and daily gains during the housing period.

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Previous Performance. In all the considered grazing phases a compensation of previous weight changes was observed, the grazing period reducing the differences originated during the housing phase. Several mechanisms may have led to this compensation. First, animals that have been undernourished can have a higher intake capacity during a refeeding period (Ryan, 1990), as might have been the case in the grazing season of the current study, allowing them to have higher gains. Besides, their maintenance requirements may have been reduced, because of a metabolic adaptation to underfeeding (Ortigues, 1991), and also the energy content of weight gain of thin cows, may have been lower than that of fat ones, due to a higher protein and lower fat content (Wright and Russel, 1984).

Parity. Multiparous cows always achieved higher weight gains than primiparous ones, 17 kg on average, considering both breeds and calving seasons. This could be due to the lower grass intake capacity of primiparous cows, which can be 8 to 12% lower than that of multiparous cows, even at similar live weights and milk yields, due to a lesser degree of development of the digestive tract (Faverdin et al., 1997). Besides, whereas maintenance requirements are assumed to be proportional to metabolic weight (LW$^{0.75}$), forage intake is proportional to LW raised to the power 0.9 (Agabriel et al., 1987; Ferrer et al., 1996), so that multiparous cows do not only have a greater intake capacity, but also a higher positive energy balance relative to maintenance requirements, which can be diverted to weight gain.

Grazing experience may also account for part of the difference observed between primiparous and multiparous cows. Several authors have reported a different ability of primiparous and multiparous cows to graze on different environments (Adams et al., 1986; Dunn et al., 1988). In forest ranges, Beaver and Olson (1997) described that primiparous cows were less efficient in the use of pasture and in the search of protected areas during the winter, and therefore had higher weight losses than multiparous cows.

In the case of primiparous cows, significant differences were found in the grazing performance of both breeds, and Brown Swiss cows had lower gains than Pirenaica cows. This could be caused by a lesser degree of maturity on their first production cycle, because they were younger (2.5 vs. 3 yr old) and lighter at first calving due to their higher sexual precocity (Olleta et al., 1993). However, this different reproductive management for heifers of both breeds had been established considering the differences in rate of maturity and that there were no negative consequences for Brown Swiss primiparous cows calving as 2.5-yr-olds when compared with those calving as 3.0-yr-olds. Although weight and height at calving were reduced (40 kg and 3 cm, respectively), reproductive rates and calf gains were unaffected by an earlier calving, provided appropriate bulls were used and that the cows were adequately managed after calving (Revilla et al., 1992b). Under these conditions, it seemed more economically profitable to have Brown Swiss cows calving for the first time at 2.5 yr of age rather than to maintain them nonproductive for a further 6-mo period. Similar conclusions were drawn in studies done with other breeds (Neville et al., 1988). In the case of Pirenaica cows, unless higher growth rates were achieved, which may have a negative effect on mammary development and subsequent milk yields (Bagley, 1993), calving at 3 yr of age is recommended (Revilla et al., 1992b).

The common management recommendations suggest that primiparous cows should gain up to 100 kg until their fourth calving, 50 kg of which should be gained during the grazing period after the first calving (Jarige, 1974). This was not the case in the current study, whatever the breed or calving season, which implies that these cows may reach their mature weight at older ages than when exposed to less restrictive environments, as Taylor et al. (1981) observed in other breeds. The convenience of applying higher feeding levels during the housing period or even reducing the length of the grazing season of primiparous cows should be considered in these conditions, though in the framework of extensification an early weaning of first-calf heifers may be the least costly alternative.

Breed. Considering the whole grazing season, Pirenaica cows had higher weight gains than Brown Swiss cows, although the difference was only significant during the autumn on forest pastures. Several studies have provided evidence that breeds with higher milk yield potentials have lower gains on pasture than those with lower milk yields (Montaño-Bermúdez and Nielsen, 1990; D’Hour et al., 1995), although other authors report that high milk yields do not necessarily limit
weight recovery on pasture (Wright et al., 1994). In agreement with the latter, the gains of cows of both breeds were not different during the summer lactation period in this study. This may be due to the higher intake capacity of lactating Brown Swiss cows, evidenced in the work by Casasús (1998), in which the higher milk yield of Brown Swiss cows (7.64 vs 5.80 kg/d) stimulated their voluntary forage intake.

The higher milk yield potential of Brown Swiss cows (Blasco et al., 1992) was reflected in the significantly higher growth rates of their calves during the housing period. The milk yield during this period had been estimated by machine milking or by the weigh-suckle-weigh technique in a sample of 237 lactations from Brown Swiss cows and 111 from Pirenaica cows from 1988 to 1996 and averaged 8.37 and 7.28 kg/d, respectively (Villalba, unpublished data). During the summer, however, the difference in calf gains was smaller and only tended to be significant, which suggests that Pirenaica calves may have compensated for the lower milk yields of their dams with higher grass intakes while herbage availability and/or quality was not restricting, as has been demonstrated in other breeds (Baker et al., 1976). However, Pirenaica calves still had lower weights at weaning than Brown Swiss calves, as Villalba et al. (2000) described.

The differences found in the gains of cows during the autumn on forest pastures are not likely to be due to a different intake capacity, because no differences have been found in the voluntary intake of different forages by pregnant cows of either breed (Casasús, 1998). Diet selection may also have influenced performance on forest pastures. The diet composition of Brown Swiss and Pirenaica cows of this herd was studied by microscopic analysis of feces by García-González et al. (1992). Under the free ranging conditions and stocking rates described above, and both in high mountain ranges and forest pastures, they found that the degree of diet selection was similar in both breeds through the grazing season. Grazing behavior has not been studied on these ranges, and though it was identical on natural meadows (Casasús et al., 2000), it is possible that breed differences could be expressed in these more heterogeneous environments. Yet, performance on woodland pastures during the autumn was low in both breeds; as Adams et al. (1987) suggested, when no supplement is provided cows cannot maintain weight on forest ranges during this season.

Calving Season. The differences in grazing performance in relation to calving season were larger than those related to breed, autumn-calving cows having higher and more constant weight gains through the different years. During the summer, lactation impaired the possible weight gains of spring-calving cows, whereas cows in middle to late pregnancy had lower energy requirements and thus higher gains. However, it is remarkable that although the performance of lactating cows had a wide range of variation through the years, calf gains were quite constant, as McCall et al. (1988) described. Possible causes for this were that lactating cows had been able to buffer calf growth, so that in summers when forage availability or, more likely, herbage quality, was low, milk production had been prioritized over cow weight gains. Calves may also have been able to maintain a higher relative nutrient intake from grass than their dams, because calves graze more selectively, harvesting grass with lower fiber and higher N content than larger cattle (Ferrer and Petit, 1995). In the work by McCall et al. (1988) the weight cost to cows of lactating on poor-quality pasture was not considered a major disadvantage, although it may increase winter feed requirements. In our conditions, this circumstance is aggravated by the weight loss observed when spring-calving cows grazed on forest ranges during the autumn, when herbage intake can be limited both by the lower quality of mature grass and also by the reduction of daylight hours, limiting grazing time (Demment et al., 1995). In this situation, body condition should be checked through the autumn grazing period, in order to determine the most appropriate date of housing each year that will not impair subsequent animal performance.

Autumn-calving cows grazed on these forest areas during the spring, at the beginning of the period of vegetative growth, and had significant weight gains. Although the daily gains were higher when cows were turned out later in the spring, the reduction in feeding costs associated with an early turnout has to be considered in terms of economic efficiency. As the animals grazed the hills following the altitudinal gradient of herbage growth (Revilla et al., 1995) herbage quality and availability was sufficient to allow for live weight gains during the whole spring. These results would support the suggestion of Petit et al. (1992) that weight recovery should be ensured at the beginning of the grazing period, because at the end “nutrient intake is likely to be lower and less certain.”

Comparisons of animal performance throughout the year depending on calving season have been carried out in different extensive production systems. In New Zealand, Montgomery and Davis (1987) noted that autumn-calving cows had constant weight gains during the vegetative period, and thus achieved higher weights at calving that allowed for higher losses during lactation. Similar results were described in terms of weight (Sinclair, 1997) and body condition (Lowman et al., 1976) in Scottish lowland conditions.

Russel and Broadbent (1985) compared the evolution of body condition score throughout the production cycle in autumn- and spring-calving herds in upland and hill farms in the United Kingdom, and their results were similar to those previously described. They suggested that, provided the level of body reserves at the beginning of the housing period was adequate, both spring- and autumn-calving cows could be undernourished to a certain degree during the housing period without impairing their performance. However, because the quantity and quality of summer grass required by autumn-
calving cows was lower, the recovery of reserves at pasture would be higher in this management system, which allowed for higher losses indoors.

In the current study, autumn-calving cows had a certain weight loss during the winter, though its magnitude was not as large as that described in the works cited above, up to 100 kg in their cases vs 30 kg in our conditions (Figure 2). Spring-calving cows in this study lost some weight during the lactation period indoors (around 20 kg) but had significant maternal weight gains in late pregnancy during the first half of the housing phase, which allowed them to have similar weights at both consecutive calvings (Figure 2). This means that if a target condition score at calving has to be ensured in order to achieve adequate reproductive performance (Wright et al., 1992), spring-calving cows have to be fed over their maintenance and pregnancy requirements during the first part of the winter housing period, and not under their requirements, as is suggested in other conditions (Jarrige, 1974; Russel and Broadbent, 1985) in which the recovery of reserves during the grazing period is significantly larger. This will result in a lower contribution of grazed herbage to the annual amount of energy obtained from the diet, which in other European areas of extensive beef cattle production can reach up to 73% in herds calving in late spring (DHour et al., 1998). More than to herbage availability, this difference may be due to the lower herbage quality of forest and mountain pastures in our conditions. Besides, the important vertical movements and distances traveled on these ranges where animals have free access to large foraging areas (Villalba et al., 1995) result in increased energy requirements that limit animal performance.

Reproductive Performance. The adequacy of the breeds and reproductive management practices described in this paper to a production system based on extensive use of grazed pasture depends ultimately on their attainment of adequate reproductive performance under the conditions imposed by the environment. In order to study the reproductive performance of the herd, the length of the postpartum anestrus (interval from calving to first ovulation) was measured in all the cows involved in the current study (Sanz, 2000). Throughout the 8-yr period of study blood samples were taken three times per week during the housing period after calving and analyzed for progesterone using the methodology described by Revilla et al. (1992a). The postpartum anestrus interval was significantly shorter in autumn- than in spring-calving cows (35.5 vs 49.1 d, respectively, \( P < 0.01 \)). However, when weight at calving was included as a covariate the difference was not significant (45.8 vs 39.1 d, not statistically significant), and was negatively correlated with length of the postpartum anestrus \( (r = -0.33, \ P < 0.001) \). These results are in agreement with those observed by Revilla et al. (1992a), who already described shorter postpartum anestrus in autumn- than in spring-calving cows in Pyrenean mountain conditions, not related to seasonal effects on reproduction but to a different body condition at calving. Moav (1966) stated that profitability depends on both productivity and reproductivity, and according to these results, the reproductivity of the autumn-calving herd would be ensured by the larger recovery of reserves during the grazing season, enabling a better weight and condition at calving than that observed in spring-calving cows.

When the comparison was established between Brown Swiss and Pirenaica cows in the spring-calving herd, the postpartum anestrus interval was similar in both breeds (49.1 d in Brown Swiss cows, 44.5 d in Pirenaica cows, not statistically significant). Although weight gains during the grazing season were slightly higher in Pirenaica cows when they were fed at equal nutritional levels during the housing period before calving, Brown Swiss had higher maternal gains and reached similar weights at calving and had similar reproductive performance. This implies that in reproductive terms they were equally well-adapted to the management conditions and the production system described above, despite their different milk yield potential. Although in situations of severe feed restrictions animals of higher potential for production may be at disadvantage (Nugent et al., 1993), when the availability of feed resources is sufficient, biological types of different milk potential can have different patterns of live weight change through the annual cycle that enable them to have comparable reproductive performance (Montaño-Bermúdez and Nielsen, 1990).

Implications

Unlike what has been described in other areas of extensive cattle production, our results imply that calving in the autumn is safer in order to ensure an adequate level of body reserves at calving, a major factor controlling postpartum ovarian reactivation, whereas cows calving in the spring may need increased prepartum feeding levels at the start of the housing period to reach sufficient body condition at calving. The lack of seasonal effects on reproductive performance in our conditions suggests that both calving seasons are equally practical alternatives in this environment. Moreover, the coexistence of both calving strategies in a single farm allows for diversifying calf sales and for a more rational use of grazing resources. On the other hand, Brown Swiss and Pirenaica cows had similar performances on pasture. Therefore, the choice of one or the other should be based on other more differentiating criteria, such as their degree of adaptation to high mountain conditions or meat and carcass quality of the products.

Literature Cited


