

PERFORMANCE AND INGESTIVE ACTIVITY OF BROWN SWISS AND PIRENAICA COWS AND THEIR CALVES DURING THE SPRING ON VALLEY MEADOWS

RENDIMIENTOS Y ACTIVIDAD INGESTIVA DE VACAS DE RAZA PARDA ALPINA Y PIRENAICA Y SUS TERNEROS EN PASTOREO DE PRADERAS DE FONDO DE VALLE DURANTE LA PRIMAVERA

Casasús, I.¹, R. Ferrer¹, A. Sanz¹, D. Villalba² and R. Revilla¹

¹Departamento de Producción Animal. Servicio de Investigación Agroalimentaria. Diputación General de Aragón. P.B. 727. 50080 Zaragoza. España.

²Current address: Departamento de Producción Animal. Universitat de Lleida. Avda. Rovira Roure 177. 25006 Lleida. España.

ADDITIONAL KEYWORDS

Beef cattle. Natural meadows. Grazing behaviour. Milk production. Weight gain. Genotype.

PALABRAS CLAVE ADICIONALES

Vacuno de carne. Praderas naturales. Comportamiento en pastoreo. Producción de leche. Ganancias de peso. Genotipo.

SUMMARY

Ten Brown Swiss and ten Pirenaica spring-calving cows and their calves were turned out to natural pastures after two months of lactation indoors (end of April). The level of feeding during the housing period was 100 per cent of their theoretical energy requirements, averaged for both breeds. Animal performance was measured both indoors and on pasture, and grazing behaviour on pasture was also recorded. During the housing phase, Pirenaica cows tended to gain more weight (0.144 vs -0.049 kg/day, $p=0.06$) and Brown Swiss cows had higher milk yields (6.51 vs 4.21 kg/day, $p<0.01$), and thus their calves grew faster (0.811 vs 0.644 kg/day, $p<0.05$). After turnout, the performance of cows and calves was significantly improved. Brown Swiss cows still had lower gains (0.229 vs 0.539 kg/day, $p<0.05$) and higher milk yields (9.87 vs 7.57 kg/day, $p<0.001$) than Pirenaica cows, indicating different patterns of energy partition. However, there were

no differences in calf performance in this period (1.058 vs 0.977 kg/day, Brown Swiss and Pirenaica, respectively, NS), which suggests that herbage intake could have at least partially compensated for the lower milk intakes of Pirenaica calves. Daily grazing time was identical for both breeds (568 vs 567 minutes, NS) and so was biting rate (55.4 vs 57.2 bites/minute, Brown Swiss and Pirenaica, respectively, NS), although both traits had little relationship with animal performance. Only milk yield and the number of daily bites tended to be positively correlated.

RESUMEN

Tras dos meses de lactación en establo, diez vacas de raza Parda Alpina y diez de raza Pirenaica y sus terneros pastaron durante 45 días en praderas de fondo de valle en el Pirineo Arago-

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nés. El nivel de alimentación durante la fase de estabulación se calculó para cubrir el 100 p.100 de sus necesidades energéticas teóricas. Se midieron los rendimientos de los animales tanto en establo como en pastoreo, y se estudió también el comportamiento en pastoreo de las vacas. Durante la fase de estabulación, las ganancias de peso tendieron a ser superiores en las vacas de raza Pirenaica (0,144 vs -0,049 kg/día, $p=0,06$), mientras que las vacas de raza Parda Alpina presentaron mayor producción de leche (6,51 vs 4,21 kg/día, $p<0,01$), por lo que los crecimientos de sus terneros fueron superiores (0,811 vs 0,644 kg/día, $p<0,05$). Tras la salida al pasto se mejoraron sensiblemente los rendimientos de los animales. Las vacas de raza Parda Alpina presentaron menores ganancias de peso (0,229 vs 0,539 kg/día, $p<0,05$) y mayor producción de leche (9,87 vs 7,57 kg/día, $p<0,001$) que las de raza Pirenaica, indicando diferentes pautas de reparto de la energía. No se observaron diferencias en las ganancias de peso de los terneros en el pasto (1,058 vs 0,977 kg/día en Parda Alpina y Pirenaica, respectivamente, NS), lo que sugiere que los terneros de raza Pirenaica podrían haber compensado, al menos en parte, la menor ingestión de leche con una mayor ingestión de hierba. El tiempo de pastoreo diario y la frecuencia de bocados fueron idénticos en ambas razas (568 vs 567 minutos y 55,4 vs 57,2 bocados/minuto en Parda Alpina y Pirenaica, respectivamente, NS). La relación entre estos parámetros y los rendimientos de los animales fue escasa, aunque la producción de leche tendió a correlacionarse positivamente con el número de bocados diarios.

INTRODUCTION

In mountain conditions, the traditional production system involves a late turnout to pasture, close to mid June. The herds are generally directly turned out to high mountain ranges (1500-2000 m), while the pastures in

lower areas are left for hay production. An earlier turnout to these lower pastures could be an alternative practice aiming at the extensification of this system, by means of reducing the length of the housing period and the costs associated to the process of preservation of harvested forages, so that this grass could be directly grazed by the animals in early spring and then cut later in the summer with optimum quality.

The use of these lower areas is, however, constrained in time by the need of an optimum use of high mountain ranges, where herbage production and quality is high at the beginning of the summer and then decreases sharply due to either dry or cold weather. Petit *et al.* (1992) suggested that *complete replenishment of body reserves in spring is important because nutrient intake in summer and autumn is likely to be lower and less certain*, which has been confirmed in Pyrenean mountain conditions (Casasús, 1998).

Pirenaica and Brown Swiss cattle are two of the suckler breeds more widespread over the Spanish Pyrenees for calf production. The first one is an autochthonous blonde breed traditionally used in this area, although its population decreased when new breeds were introduced as a consequence of an intensification in milk production. Brown Swiss cattle were introduced in the area with this purpose more than a century ago, although most farms have now abandoned this option and use this breed only for producing weaned calves (Manrique *et al.*, 1992).

Mature weight is very similar in

both breeds, and the main differences between them have been found in aspects related to milk production, Brown Swiss cows having higher yields (Casasús, 1998) and their calves growing faster through weaning (Villalba *et al.*, 2000). In terms of reproductive traits, although Brown Swiss heifers reach puberty at similar weight but younger age than Pirenaica heifers, due to a faster maturing rate (Revilla *et al.*, 1992), no differences have been found in the reproductive rates of adult cows under identical management conditions (Revilla, 1997). However, the meat production ability is higher in Pirenaica animals, due to better carcass conformation and carcass yield (Albertí *et al.*, 1999).

Several authors have reported breed differences in animal performance (D'Hour *et al.*, 1995; Wright *et al.*, 1994) and grazing behaviour on pasture associated to a different potential milk yield (Funston *et al.*, 1991), that can be related to different herbage intake (Wagner *et al.*, 1986). Although wide research has been done on several production traits of Brown Swiss and Pirenaica cattle, little information has been provided on possible differences on grazing behaviour or patterns of energy partition during lactation.

Therefore, the objectives of this experiment were to determine the effects of an early turnout to pasture on the performances of Brown Swiss and Pirenaica cows and their calves and also to relate them to grazing behaviour, and to test whether there were differences in the response of both breeds to turnout when compared with their performance indoors.

MATERIAL AND METHODS

SITE AND EXPERIMENTAL DESIGN

The experiment was conducted at La Garcipollera research station, in the Central Spanish Pyrenees. The experimental site was at an altitude of 950 m above sea level, with an average annual precipitation of 999 l/m².

Two groups of Brown Swiss and Pirenaica spring-calving cows and their calves were used in this study. After calving, the animals were kept indoors for the first two months of lactation. Then they were turned out to natural meadows, where they grazed for a month and a half until they were moved to high mountain ranges for the summer.

ANIMALS, SWARDS AND MANAGEMENT

Ten Brown Swiss and ten Pirenaica cows and their calves were involved in this experiment. The animals had been housed during the last three months before calving (average calving date 24 February). During the first two months after calving they were housed and group-fed with a diet intended to cover 100 per cent of their energy requirements for maintenance and lactation, calculated upon the average weight and milk yield of both breeds using Agricultural Research Council (1980) equations. The amount of feed offered was the same for both breeds and consisted of 5.7 kg DM barley straw and 7.3 kg DM cube-shaped dehydrated lucerne per cow and day. The chemical composition of the feedstuffs is shown in **table I**. During this period calves did not receive any supplement and were fed only on their dams' milk, suckling twice daily in

Table I. Chemical composition (g/kg DM) of the forages used during the housing period. (Composición química (g/kg MS) de los alimentos utilizados durante la fase de estabulación).

	Barley straw	Dehydrated lucerne
Organic matter	907	819
Crude Protein	35	187
Acid-detergent fibre	514	256
Acid-detergent lignin	80	56

two periods of 20 min each.

Two months after calving (30 April) the animals were turned out to pasture and grazed for 44 days in a paddock. This paddock was a 4-ha natural pasture, which had received 4000 kg manure and 70 kg N per ha three months earlier. The predominant species in the meadow were *Festuca arundinacea*, *Poa pratensis* and *Trifolium repens*. The animals were set stocked at a stocking rate of five cows per ha. Water and mineral-vitamin mixture blocks were supplied *ad libitum*.

MEASUREMENTS

Live weights (LW) of cows and calves were recorded at calving, at turnout and at the end of the experiment by double weighing. During the grazing period, weights were recorded at weekly intervals. Average daily gains (ADG) were calculated by linear regression of weights on days, using as initial weight for the grazing period the one recorded one week after turnout, in order to account for the loss of weight due to changes in digestive

content. Body condition score (BCS) on a 0 to 5 scale (Lowman *et al.*, 1976) was also recorded at calving and at the beginning and end of the grazing period.

Cow milk yield was estimated the day before turnout and then weekly during the grazing period, by the oxytocin and machine milking technique (Le Du *et al.*, 1979). Individual samples of milk were analysed for fat, protein, non-fat solids and lactose, using an infrared technique (Milkoscan 255 AB, Foss Electric Ltd., U.K.).

Sward surface height, herbage mass and chemical composition were measured weekly. Sward height was measured using the HFRO sward stick, taking 100 measurements at random in the paddock on each occasion. Herbage mass was measured by clipping with an electric mower all plant material 2 cm above ground level in six 0.25 m² quadrats randomly located in the paddock. Herbage samples were analysed for organic matter content, Kjeldahl-N and acid-detergent lignin and fibre (Goering and Van Soest, 1971).

Grazing behaviour was measured weekly throughout the grazing period, on the same day as sward measurements were taken. Grazing time was measured by visually recording the behaviour of each animal every 5 minutes from 05.30 to 23.00 h, as previous observations had shown no evidence of night grazing in these conditions. Biting rate was simultaneously measured by counting with a hand-held counter the number of bites taken over 2 minutes during grazing periods, providing at least 8 measurements per animal were taken throughout the day.

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Table II. Initial, final and average herbage chemical composition (g/kg DM), sward height (cm) and herbage mass (kg DM/ha). (Composición química de la hierba (g/kg MS), altura (cm) y disponibilidad (kg MS/ha), datos iniciales, finales y medias).

	Chemical composition			Sward height and herbage mass			
	Initial	Final	Average	Initial	Final	Average	
Organic matter	890	854	881	Sward height	23.6	9.1	14.5
Crude protein	194	154	168	Herbage mass	3037	1143	2166
Acid-detergent fibre	267	300	281				
Acid-detergent lignin	25	34	31				

STATISTICAL ANALYSES

Data were analysed using SAS Statistical Package (SAS, 1990b). Grazing behaviour and milk yields were analysed using a General Linear Models procedure with repeated measurements, testing breed as a fixed effect and days as replicates. Weight and condition score changes were analysed considering breed as a fixed effect and their initial values as covariates. The relationships between variables were measured with Pearson correlation coefficient, after testing that the variables were normally distributed using the Shapiro-Wilk statistic W (SAS, 1990a). Predictive models were obtained by linear regression (step-wise method).

RESULTS

SWARDS

The initial, final and average sward height, herbage mass and chemical composition throughout the six-week grazing period are given in **table II**. During this period, sward height and herbage mass decreased in a similar pattern, and so did herbage quality-

protein content was reduced while fibre content increased.

COW PERFORMANCE

Cow and calf performances during the housing and grazing phases are shown in **tables III** and **IV** respectively.

Cows of both genotypes had similar weights at calving (527 vs 528 kg

Table III. Cow and calf performance during the housing period. (Rendimientos de las vacas y los terneros durante la fase de estabulación).

	Brown		s.e.d.	Sign. ^a
	Swiss	Pirenaica		
Calving LW, kg				
cow	527	528	21.13	NS
calf	40.2	36.4	2.14	0.10
ADG, kg				
cow	-0.049	0.144	0.095	0.06
calf	0.811	0.644	0.076	*
BCS				
initial	2.25	2.12	0.049	NS
final	2.21	2.17	0.073	NS
gain	-0.04	0.05	0.102	NS

^aLevel of significance: *p< 0.05, NS: non-significant.

Table IV: Cow and calf performance during the grazing phase. (Rendimientos de las vacas y los terneros durante el periodo de pastoreo).

	Brown		s.e.d.	Sign. ^a
	Swiss	Pirenaica		
Initial LW, kg ^b				
cow	514.8	518.0	9.26	NS
calf	88.7	79.2	2.71	NS
Final LW, kg				
cow	533.3	553.8	8.45	NS
calf	133.0	119.8	4.04	NS
ADG, kg				
cow	0.229	0.539	0.066	*
calf	1.058	0.977	0.043	NS
BCS				
initial	2.21	2.17	0.033	NS
final	2.45	2.60	0.020	**
gain	+0.24	+0.42	0.027	**

^a Level of significance: * $p < 0.05$, ** $p < 0.01$, NS: non-significant; ^b LW one week after turnout.

Brown Swiss and Pirenaica, respectively, NS) and were also balanced in calving dates (28 vs 22 February, e.s.d.= 8.3, NS). During the first two months of lactation Brown Swiss cows had slight weight losses (-49 g/day) while Pirenaica cows gained 144 g/day ($p=0.06$).

At turnout, cows of both breeds lost 17 kg live weight during the first week on pasture due to changes in digestive content. In the following weeks they had both weight and condition score gains, which were higher in Pirenaica cows.

Milk yield and composition before turnout and the average records on pasture are given in **table V**. Milk yield was 2.3 kg higher in Brown Swiss

cows both when registered indoors and on pasture. On the first week after turnout milk yield increased rapidly (+2.17 kg, s.e. 0.38) until it reached a maximum on the third week at pasture (**figure I**). As a whole, milk yield on pasture was 3.36 kg (s.e. 0.48) higher than that recorded indoors, this difference being constant in both breeds.

Fat, lactose and non-fat solids content were higher in Pirenaica cows, the difference being larger in the grazing period. After turnout fat, protein and non-fat solids content increased in both breeds.

During the grazing phase cows of both genotypes improved their body condition, although the gains were higher in Pirenaica cows. These gains were influenced by initial BCS in both breeds, and also by milk yield in the case of Brown Swiss cows, their relationships in each breed being as follows:

Brown Swiss:

$$\text{BCS gain} = 2.20 (\text{s.e. } 0.416) - 0.45$$

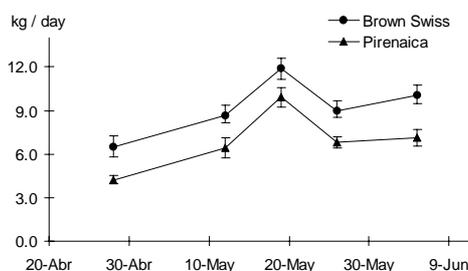


Figure I. Milk yield (kg/day) throughout the experiment. (Evolución de la producción lechera (kg/día) a lo largo del ensayo).

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Table V. Milk yields and composition of both breeds before turnout and during the grazing experiment. (Producción y composición de leche previa a la salida al pasto y durante la fase de pastoreo).

	Before turnout				Grazing period			
	Brown Swiss	Pirenaica	s.e.d.	Sign. ^a	Brown Swiss	Pirenaica	s.e.d.	Sign. ^a
Milk yield (kg/d)	6.51	4.21	0.340	**	9.87	7.57	0.235	***
Composition (g/kg)								
Fat	30.4	33.4	1.12	NS	33.1	40.6	0.65	***
Protein	32.2	37.1	0.59	**	38.7	38.8	0.46	NS
Non-fat solids	83.6	92.3	0.72	***	89.0	94.9	0.60	***
Lactose	44.0	47.7	0.97	NS	42.7	48.6	0.84	**

^a Level of significance: **p< 0.01, ***p< 0.001, NS: non-significant.

(s.e. 0.142) * Initial BCS - 0.10 (s.e. 0.042) * Milk Yield

R²= 0.80 D.E.R.=0.078

Pirenaica:

BCS gain = 2.70 (s.e. 0.361) - 1.50 (s.e. 0.166) * Initial BCS

R²= 0.83 D.E.R.=0.044

CALF WEIGHTS

Brown Swiss calves were heavier at birth (40.2 vs 36.4, p=0.10) and then grew faster during the housing period (0.811 vs 0.644 kg/day, p<0.05), which led them to be 9.5 kg heavier at turnout, although this difference was not significant (p=0.13).

Unlike cow milk yields, calf gains on pasture were similar in both breeds, so that by the end of the experiment Brown Swiss calves were only slightly heavier than Pirenaica calves, although not significantly (p=0.15).

Calf gains were positively related to their dams' milk yield during the housing period (r=0.53, p<0.05), but not during the grazing experiment.

GRAZING BEHAVIOUR

Grazing behaviour results are summarised in **table VI**. There were no differences between both breeds in daily grazing time, which in fact was identical, neither in biting rate or, consequently, the average number of daily bites (grazing time X biting rate).

The grazing patterns through the day were also similar in both breeds, having 3 to 4 grazing bouts per day with 2 to 3 resting periods between them. In late spring the differences between grazing and resting bouts were more marked.

Daily grazing time and biting rate increased throughout the experimental period, following the same pattern in both breeds. These increments were related to the decrease in sward surface height and herbage mass, the correlations being r= -0.84 and -0.92 respectively for grazing time and r= -0.90 in both cases for biting rate.

No relationship was observed between individual grazing activity and

Table VI. Grazing behaviour of cows of both breeds. (Comportamiento ingestivo de las vacas de ambas razas).

	Brown Swiss	Pirenaica	s.e.d.	Sign. ^a
Grazing time, minutes/day	568	567	7.56	NS
Biting rate, bites/minute	55.4	57.2	0.69	NS
No. daily bites, bites/day	31454	32407	551	NS

^aLevel of significance: NS: non-significant.

weight or condition score gains, but there tended to be a positive correlation between milk yield and the number of daily bites ($r=0.49$ and $r=0.52$ in Brown Swiss and Pirenaica cows, respectively, $p<0.10$).

DISCUSSION

An early turnout to natural meadows in these conditions improved the performance of cows and calves of both breeds when compared to their performance during the housing period.

Milk yield and protein content were significantly increased after turnout, as has been widely described in other experiments (Hodgson *et al.*, 1980). This increase was progressive, reaching a maximum in the third week, as Coulon *et al.* (1986) described. Both increments are associated to the improvement of the nutritional level at turnout, although they can also be promoted by the change of environmental and management conditions or diet quality (Coulon, 1995).

The increase in milk yield observed in this study (3.36 kg, 63 per cent) is higher than those generally recorded

in dairy cows (Coulon *et al.*, 1986; Coulon, 1995). However, the increase in yield has frequently been related to previous feeding level and the initial yield, which can explain that our results are closer to those observed by other authors working with suckler cows fed at restricted energy levels during the housing period and with lower milk yields than the dairy genotypes (Hodgson *et al.*, 1980).

Calf performance during the housing period mirrored the differences in milk production, as they had no other food available. After turnout, calf growth rates increased following the increase in milk yield. However, the breed differences observed in milk production were not reflected on calf gains, which were similar in both breeds.

Calves are capable of consuming pasture from one month of age, although at this age milk is still the major source of energy intake. The relationship between milk and forage intake is negative and changes of its value reflect the degree of development of the rumen and of solids intake capacity. Calves can eat 0.89 to 0.95 kg forage per kg reduction in milk intake (Le Du and Baker, 1979; Wright

and Russel, 1987), providing their intake capacity of 10 to 15 g forage per kg live weight at this age (Le Neindre *et al.*, 1976) is not exceeded.

Herbage grazed by calves can therefore compensate for a low milk intake, although compensation can only be complete if herbage quality and availability are enough, e.g. Wright and Russel (1987) and Wright *et al.* (1994) reported a compensation when sward height was over 7 to 10 cm. At the end of this experiment residual height was thus enough to allow for this compensation, so that it did not limit calf forage intake, most of all taking into account that calves are less reactive to adverse sward conditions and tend to maintain their intake level better than adults when sward height is reduced (Ferrer *et al.*, 1995).

Hence, it appears that in the current study two- to four-month-old Pirenaica calves could have at least partially compensated for the lower milk intake by a higher forage intake, their gains on pasture being only slightly lower (81 g/day), though not significantly, than those of Brown Swiss calves.

Cow body condition and weight gains were significantly different between both breeds during the grazing period. This was also observed during the housing phase, when the diets were the same for both breeds and their performance was different: while Brown Swiss cows had higher milk yields and lost some weight, Pirenaica cows produced less milk and had weight gains. In fact, it is remarkable that BCS gains on pasture were negatively related to milk yields only in Brown Swiss cows, while in Pirenaica cows gains were irrespective of

milk yield, showing that their lower milk yield does not limit the recovery of reserves.

These tendencies have been detected in many other comparisons of breeds of different genetic potential for milk production, so that under the same nutritional management the genotypes with higher milk yields had lower weight gains (D'Hour *et al.*, 1995; Halloway *et al.*, 1985; Montañó-Bermúdez and Nielsen, 1990; Sinclair *et al.*, 1998). However, Wright *et al.* (1994) described that, even at similar intakes per kg live weight, high milk yields are not necessarily associated with low potential to gain weight during lactation. In this case the efficiency of energy utilisation might have been different, as can also be inferred from the results from nine breeds of cattle presented by Jenkins and Ferrell (1992).

In the current study, an energy balance was calculated in terms of net energy (NE), considering cow performance during the grazing and housing period to determine the requirements for maintenance, lactation and weight gain (Agricultural Research Council, 1980). The comparison of the energy requirements covered by the diet showed that nutritional status was improved by 54 per cent after turnout. There were no differences in the net energy obtained from the diet by the two breeds both during the housing period (53.7 and 52.9 MJ NE/day, Brown Swiss and Pirenaica, respectively, NS) and the grazing phase (78.3 and 82.1 MJ NE/day, NS). This suggests that unless the efficiency of energy utilisation was different between both breeds, their energy

intake was similar both indoors and at pasture. However, the pattern of nutrient partition between milk production and body reserves was different between them: Brown Swiss cows delivered a higher share of energy towards milk production and Pirenaica cows towards weight gains. This had also been observed by Ferrell and Jenkins (1985) in a comparison of four genotypes of different potential for milk production.

Grazing behaviour changed through the experiment in response to changes in pasture conditions. Both grazing time and biting rate increased with decreasing herbage mass and sward height, reflecting an effort to maintain intake levels.

There were no differences between both breeds in grazing behaviour, although many works report differences in grazing time and biting rate between genotypes. These are generally associated to different energy requirements, due to either different mature weight or milk yield (Erlinger *et al.*, 1990), and both behavioural traits tend to increase with increasing requirements.

However, these differences are not consistent in literature. When genotypes of different milk yields were compared, Funston *et al.* (1991) only described differences in biting rate. On the opposite, Lathrop *et al.* (1988) only found a positive correlation between milk yield and grazing time, causing an increase in forage intake. In the current study the lack of difference between the two breeds in these parameters suggests that, unless bite size was different, the herbage intake could have been similar, as was derived

from the calculated dietary energy intake.

In our experiment, social facilitation or environmental signals may have induced behavioural traits and patterns to be identical in both breeds, as a certain degree of synchronization of eating activity has been described in groups of cows grazing together (Rook and Huckle, 1995). Thus, it can not be excluded that in different conditions or if the cows of the two breeds had been managed separately differences had not occurred.

In conclusion, the improvement of cow and calf performance by an early turnout to these valley pastures before grazing on high mountain ranges might deserve consideration in the framework of the extensification of these production systems. Although it is a short period and the magnitude of cow weight gains may not seem large (18.5 and 35.8 kg in Brown Swiss and Pirenaica cows, respectively), it is important when compared with the average weight gain achieved during the whole grazing season in Pyrenean mountain conditions, studied over 8 years (13.5 and 20.6 in Brown Swiss and Pirenaica multiparous cows, respectively (Casasús, 1998)). In a study similar to that presented here, an early turnout to natural meadows was also associated to a higher herbage quality maintained throughout the grazing season and a better use of the available grass (D'Hour *et al.*, 1996). However, a proper economic evaluation should be carried out, taking into account, apart from long-term effects of this practice on the sustainability of these type of pastures, the reduction of hay production but also the reduction

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of feeding costs and labour for a shorter housing period.

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