Livestock production systems and the vegetation dynamics of Less Favoured Areas (LFAs): developing viable systems to manage semi-natural vegetation in temperate LFAs in Spain.

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Introduction

The designation "Less Favoured Area", defines the basis on which economic compensatory payments are applied within the Common Agricultural Policy (CAP). However, there are large differences between zones classified as "Less Favoured" in terms of social, physical and structural conditions, the environment and prevailing policies, not only within the EU, but also at a local scale within the same region. The circumstances of less favoured areas differ widely, and the opportunities for their development are extremely variable. For this reason, it is difficult to introduce general actions to solve the problems of inequality between regions if this is done independently of the degree of marginality or inequality. The degree of isolation of disadvantaged areas from markets, the education of their inhabitants and the accessibility of schools and public services differ greatly. Equally, the structure and ownership of land and the condition of the soil (quality, slope etc.) affect the availability of forage resources and consequently the possibilities for their efficient use. Thus a range of conditions can be found within Less Favoured Areas (LFAs) ranging from high quality grassland (ryegrass and clover) to enterprises with shallow soils, steep slopes, and with vegetation dominated by shrubs.

Shrubby heath vegetation covers an area of the north-west Iberian peninsula of some 1,402,500 hectares, 35 per cent of the total area, and within the two LFA regions of Galicia and Asturias (Ministerio de Agricultura, 1997). Part of this region is mountainous and in public or communal use, while the rest corresponds to areas that have been abandoned by rural exodus resulting from industrialisation in the 1950s and 1960s. Much of this heath in the last two decades has been affected by wildfires, which are a cause of real social, economic and environmental problems with important economical and enviromental losses (Figure 1), especially in Galicia, where 61% of all the wildfires in Spain occur. The area burned in Galicia represents 40 per cent of that burned each year in the whole of Spain, while Galicia itself covers only 5.8 per cent of Spain (Table 1). Of the total burned area in Galicia (24,014 ha), 85 per cent was heathland vegetation (Ministerio de Medio Ambiente, 1997).

The exploitation by grazing livestock of these large areas of heath, generally within LFAs, could be the basis for the development of economically sustainable livestock systems. Such agricultural use would make a significant reduction to the risk of fires and erosion, favour biodiversity and landscapes, as well as generating social and economic benefits. Investment in equipment, infrastructure and personnel for fire prevention and to extinguish fires has reached millions of euros. However the appropriate management of these soils and vegetation resources requires knowledge of the interactions between available vegetation,

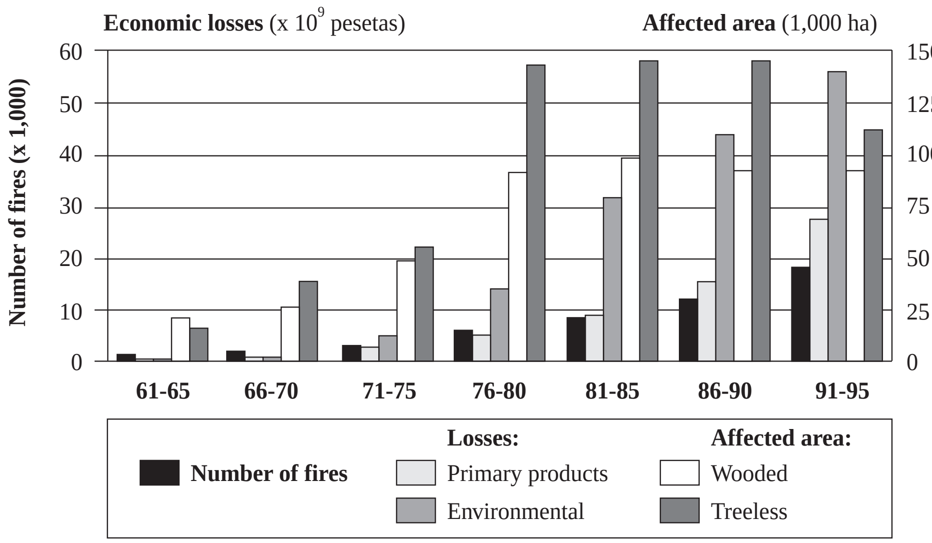

Figure 1. Annual incidence of fires, areas affected and economic losses in Spain.

Table 1. Number of fires and vegetation cover affected in three less favoured areas in regions in the north west of Spain.

		Proportion in LFA per region		
	Spain (Total)	Galicia (%)	Asturias (%)	Castilla-León (%)
Total land area (km^2)	505,990	5.8	2.1	18.6
Number of fires	16,772	61.0	4.2	9.1
Total area burned (ha)	59,824	40.1	5.9	29.1
of which:				
Woodlands (ha)	10,538	32.9	5.0	25.0
Scrubland (ha)	41,751	48.8	6.8	30.3
Losses (Euro)	30 million	36.2	5.2	22.4

grazing animal species, utilisation strategy and marketing conditions.

Available grazing resources and their utilisation

As stated, the vegetation of LFAs exhibits great diversity, owing to variability in soil characteristics and environmental variants. Equally, animal species and breeds within each species, demonstrate behaviour and variable responses such that there are many alternative possibilities and strategies to develop viable systems. The optimum management response will result from consideration of the interaction between the two principal factors: the vegetation and the animal. This response will vary according to the management strategies for both factors, the market conditions for the sale of the produce, and the benefits to the environment that are achieved by this system.

Within each principal factor, the variation is great: vegetation differs in growth rate, productivity, seasonality, palatability, quality and combustibility, while animals may vary in hardiness, grazing behaviour, growth potential, quality and price of products, energetic demand according to size and phase of production. Differences in nutritional value (Hodgson & Eadie, 1986) and production (Newbold, 1980) of the various herbage species of the disadvantaged areas (*Lolium - Trifolium, Agrostis - Festuca, Nardus, Calluna, Ulex* spp. etc.) are known, as well as the degree of utilisation by the different farm animal species (cattle, sheep, goats) (Grant *et al.*, 1985; 1987; Clark *et al.*, 1982; Radcliffe, 1985), and breeds (Revesado *et al.*, 1994). On the other hand the degree of complementarity between the species is also variable (Lechner-Doll *et al.*, 1995) as a result of differences in their grazing behaviour (Hofmann, 1989). Such complementarity is manifested to a greater or lesser extent as a function of the degree of heterogeneity in the available vegetation (Osoro, 1995a). Eventually, this greater or lesser complementarity is translated into greater or lesser productivity per animal species and per unit area.

Some areas that are less steep, and have deeper soil, present an opportunity to improve the vegetation by organic fertilisers and reseeding with plant species of greater productivity and higher quality. In many circumstances, it can be essential to undertake this pasture improvement, in order to assure the economic sustainability of an activity that continues to be extensive. It is possible that the increased heterogeneity and productivity of these improved pastures will also favour wildlife and habitat biodiversity.

The components of available vegetation may vary in relation to management, and hence in quality and palatability. The changes caused by the exploitation of the vegetation, as well as modifying biodiversity, will place conditions on the management strategy (type of herd) and the productivity of the following cycle (Milne & Osoro, 1997). Thus the strategy for utilisation of resources is the principal variable determining the production, viability, as well as the vegetation dynamics, and consequently the sustainability of the activity. Such a strategy should be modified according to environmental conditions, given that the vegetation is dynamic.

Animal productivity will be the result of the nutritive balance of the animal, though this depends on the quantity of nutrients consumed, and the demand for nutrients of the animal. The level of intake is regulated by the utilisation of the available vegetation achieved by the different animal species, and by the nutritive quality of the diet selected. The animal's demand for nutrients varies with size, productive phase and environmental conditions. Thus, as well as available vegetation, animal species and breed are two variables that significantly influence animal production per head and per unit area, and in the vegetation dynamics of the disadvantaged area.

Utilisation strategies for grazing resources, animal productivity and vegetation dynamics

As well as the animal response, the effects that utilisation strategies have on vegetation dynamics have been analysed for the vegetation types most commonly found in the disadvantaged regions of the north-west Iberian peninsula. Heath-gorse, partially improved heath-gorse, natural grasslands made up of *Agrostis - Festuca - Nardus*, alongside *Calluna* and pasture grasses, ryegrass - clover, are also found in many other Atlantic regions of Europe. The effects on animal productivity and vegetation dynamics that will be presented relate to these vegetation communities.

Heath-gorse

The species found in heath-gorse communities have low nutritive value and palatability for ruminants. It covers large areas of land that are burnt frequently. Heath-gorse vegetation offers few opportunities for the development of animal production systems. In most cases it is possible to establish production systems with a low demand for nutrients, such as quality fibres and wool. Animals are not able to maintain live weight and body condition during the reproductive phase, as they cannot ingest sufficient nutrients necessary to satisfy the energy and protein demands of maintenance and lactation. However, to develop systems sustainable by their animal productivity, it will be necessary to have large areas that allow herds of thousands of individuals (castrate cashmere goat males, or fine wool wether lambs), though this may be to the detriment of the number of herds, or the number of farming families that may be maintained.

If animal production alone cannot be economically justified on these heather-gorse areas, the effects of grazing, in particular of goats on the dynamics of the vegetation cover, can be considered and given a value for the reduction of combustible material. Goats managed at densities of some 18 head/ha over a period of four months (May-September), are able over two years to reduce drastically the height and biomass of the shrubs, and significantly modify the proportions of the different biomass components. It is possible to demonstrate how in the goat-grazed plots mean shrub height (Figure 2) was significantly reduced in each of the two years (from 15 to 5 cm), while in the plot grazed exclusively by sheep, the shrub height was hardly affected. In studies on vegetation composition (Figure 3) an increase in the presence of herbaceous vegetation was observed in plots grazed by goats, compared with those grazed exclusively by sheep, which had little effect on the vegetation components (Celaya & Osoro, 1997).

Cattle will hardly utilise heath or gorse, and cause changes in vegetation more by trampling than by grazing. The possible

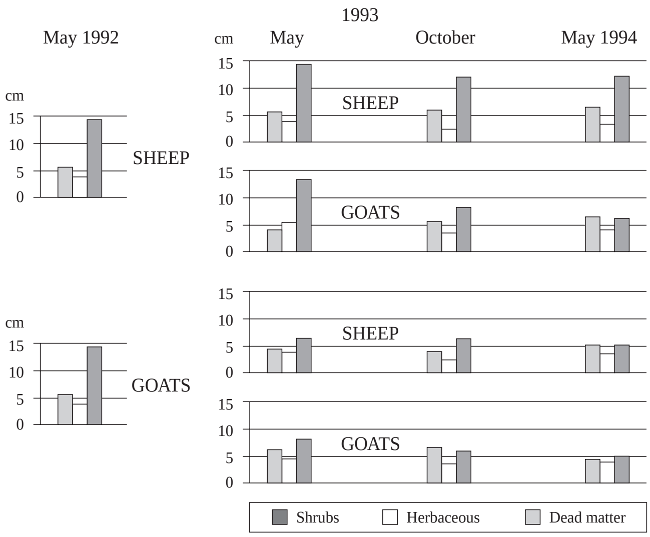

Figure 2. Evolution of mean height (cm) of the canopy in gorse-heath communities grazed by sheep or goats.

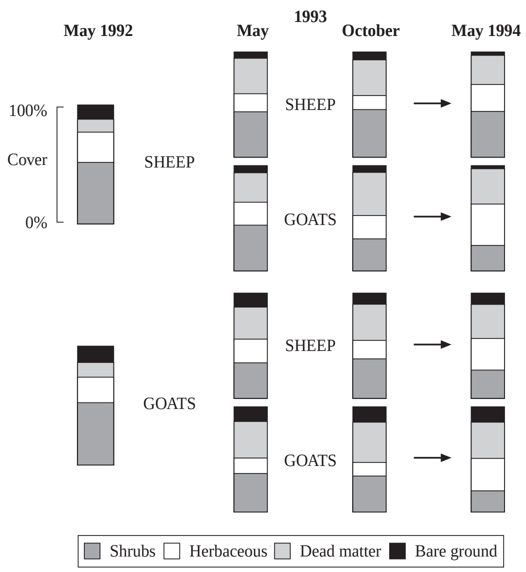

Figure 3. Evolution of percentage cover in heath-gorse communities grazed by sheep or goats.

benefits of cattle on environmental biodiversity are thus clearly less than those of goats or sheep, and may even have a damaging effect in steeper regions, where the paths of denuded soil that they create are at risk of erosion.

Partially improved heath-gorse

The improvement of part of the vegetation allows the possibility to develop sustainable extensive systems on a much smaller land area, and that will generate greater possibilities within a given area for the maintenance or establishment of a greater number of farming families. A high variation of responses has been found with respect to animal production and for vegetation dynamics in relation to available grazing resources and proportion of improved area (Osoro *et al.*, 1997a). Suckler cows increase their response in proportion to the percentage of improved pasture. Table 2 shows that the percentage of improved area should be at least greater than half the total available area, with the aim to accumulate the reserves for some of the cows, and to prolong the grazing season. The improvement of such a high proportion of the total area would have many serious physical, economic and possibly environmental limitations in many regions. However, it has been observed that for herds of sheep and goats, the improvement of one third of the available area

Table 2. Effect of proportion of improved pasture on spring (May-July) liveweight changes in winter-calving suckler cows.

	Proportion of improved pasture			
	0%		30%	100%
Number of cows grazing	6†	6	8	6
At turn-out (3 May)				
Live weight (kg)	504	478	474	496
Body condition score	2.65	2.37	2.50	2.54
Calf live weight (kg)	-	53	126	66
Liveweight change				
Cows (kg/day)	0.33	-0.36	0.24	0.89
Body condition change	+0.06	-0.45	+0.30	+0.46
Calves (kg/day)	-	0.71	1.16	1.03

† dry cows

Table 3. Liveweight changes of sheep, indigenous goats and cashmere goats during the spring (23 April - 13 July) grazing on partially improved heath-gorse vegetation.

Grazing pressure	High	Medium
Sward height (cm) (1)	4.7	6.5
Sheep liveweight(2) (kg):		
ewe	34.2	36.3
lamb	7.6	7.9
Liveweight changes (g/day)		
ewe	71	77
lamb	185	172
Indigenous goats liveweight(2) (kg):		
doe	38.3	36.7
kid	6.5	6.0
Liveweight changes (g/day)		
doe	54	84
kid	62	102
Cashmere goats liveweight(2) (kg):		
doe	34.2	35.2
kid	7.6	7.5
Liveweight changes (g/day)		
doe	42	108
kid	95	126

(1) in the improved area it was 0.33 of the total area (2) at turn-out.

Table 4. Performance of a suckler cow herd and sheep + goat mixed flock during the spring (23 April - 13 July) grazing partially improved heath-gorse (33% of total area was improved).

	Cattle	Sheep +	Goats
No. of animals (dams/young)	12/12	85/110	85/110
Liveweight changes (kg/head/day)			
dams	0.24	0.077	0.108
young	1.16	0.172	0.126
Productivity (kg LW/day)			
dam	2.88	6.54	9.18
young	13.92	18.92	13.86
Total production of the system (kg LW/day)	16.80	25.46	23.04
		48.50	

in spring is sufficient to obtain good results around parturition (April - July). Lambs have greater daily liveweight gains and were heavier than kids, though, as may be expected, there are differences between breeds (Table 3). Ewes in general also achieved greater gains than goats, though the latter can outperform ewe liveweight gain when the mean vegetation height of the improved area increases above about 7.0 cm (Osoro, 1995b). After weaning at the end of the spring grazing season (July-August), the goats can pass on to areas of only heath-gorse, where they can continue to increase their body condition and live weight during summer and early autumn at a rate of approximately 50g/day. These non-lactating goats can reduce the accumulation of shrub vegetation, and modify its composition as described above. The ewes will remain in the improved plot, where they will increase their condition until the onset of winter. In this way, small ruminants will prolong the grazing season, while cattle have difficulty to cover their maintenance requirements.

In comparing the productive responses of these species during spring grazing, it was observed that the productivity of a mixed herd of sheep and goats is between two and three times greater than that of suckler cows (Table 4), even though that is the season most favourable for the cattle, which have a greater ingestive capacity. Given the greater sward height required by cattle in comparison with sheep, and, unlike goats, their almost zero appetite for woody species, any periods of nutritional scarcity will tend to be exaggerated for cattle when compared with the small ruminants.

In relation to the health status of the animals, it has been observed that the parasite burden presented both by sheep, and in particular goats, is much less, and thus also the expense of anthelmintic treatments is reduced in comparison with goats maintained exclusively on seeded or improved pastures (Osoro et al., 1995). Equally, the incidence of other infectious ailments, such as foot rot, is also significantly diminished.

The vegetation dynamics of these partially improved heathlands is also clearly seen to be affected by animal species and the availability of improved pasture. In areas where the heath-gorse is mechanically removed, the accumulation of biomass after three years is significantly greater in plots grazed by sheep than in those with goats (Figure 4). However, this biomass accumulation under sheep grazing is considerably less than it would have been the case in the absence of any grazing (Celaya, 1998). Mixed grazing with sheep and goats restricts the accumulation of biomass to levels close to those observed in plots grazed solely by goats. In addition to the difference in

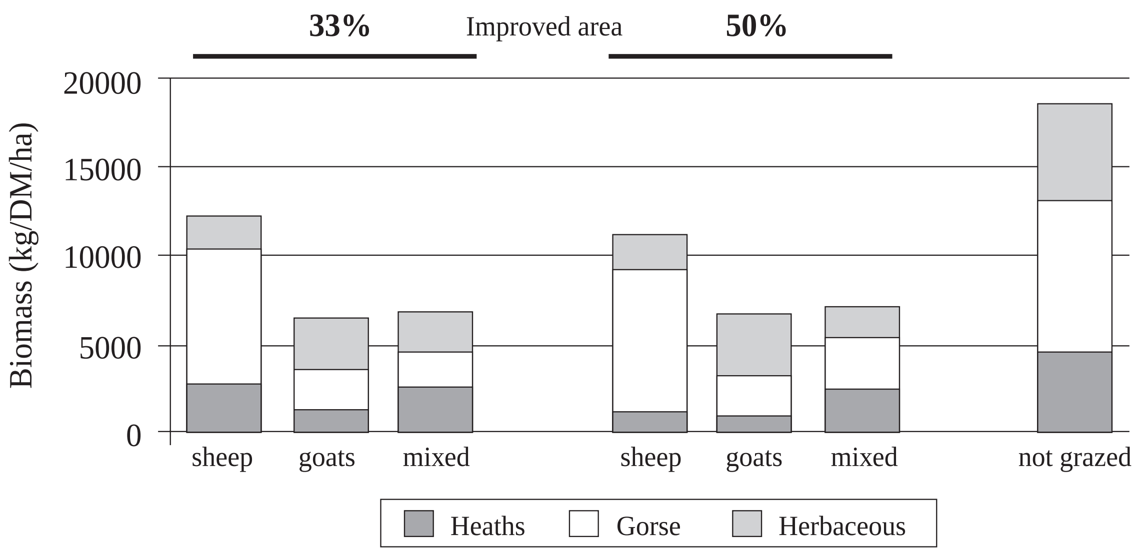

Figure 4. Amounts of biomass in mechanically-cleared areas of heath-gorse shrubland in partially improved plots (33% or 50% of the total area available in spring grazed by sheep, goats or mixed herds).

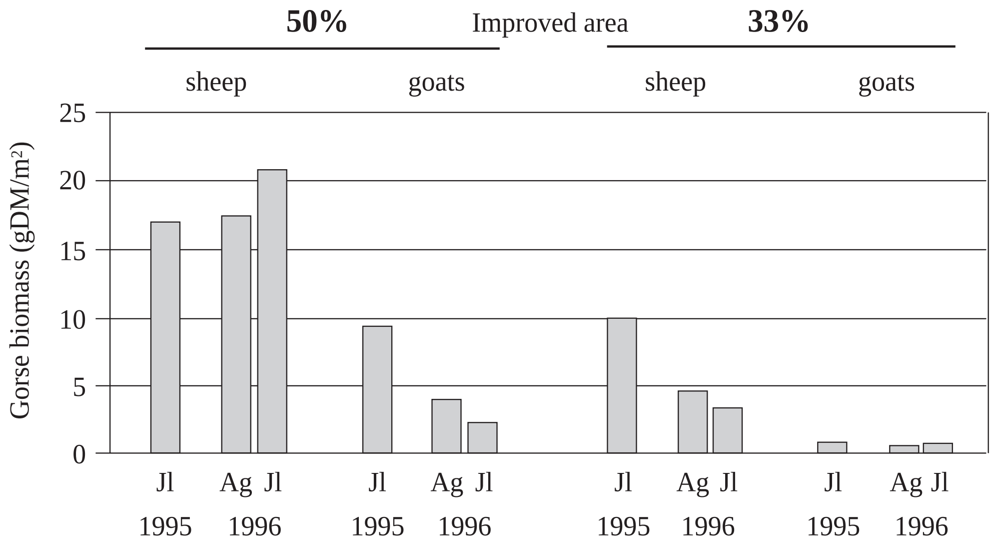

Figure 5. Gorse regrowth in the improved areas (33% and 50% of area improved).

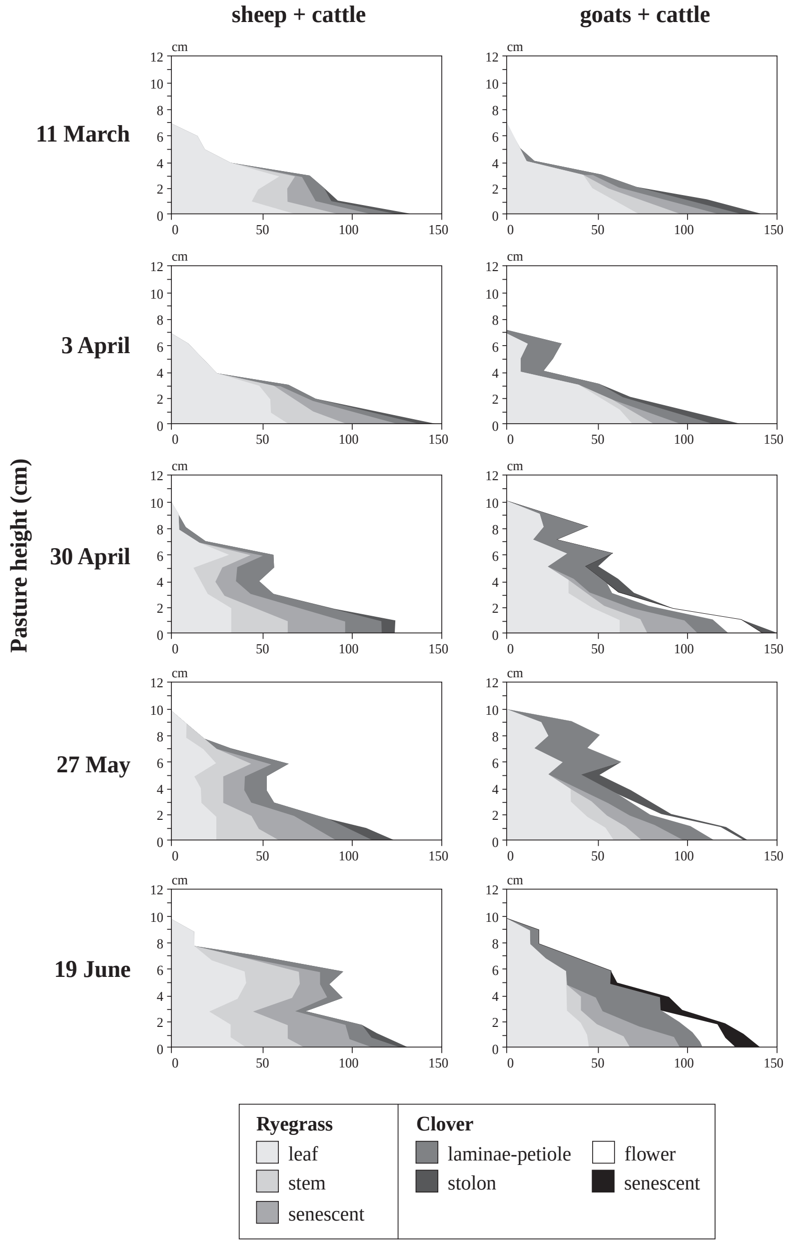

Figure 6. Differential structure of vegetation components in perennial ryegrass-white clover pastures grazed by sheep or goats with yearling calves.

quantity, the components of accumulated biomass differ significantly, woody species predominating in sheep-grazed plots, while herbaceous species are the principal components of goat-grazed plots.

In improved grassland, significant differences in vegetation dynamics are also observed. In many enterprises the control of regrowth of spontaneous mountain vegetation, especially of gorse, in areas of improved grassland is a serious problem. Our results (Figure 5), in agreement with observations in New Zealand (Radcliffe, 1986; Krause *et al.*, 1984), provide evidence that goat production is both economically and ecologically efficient at controlling the regrowth of gorse, though grazing pressure obviously has an effect. Goats, in addition, will take the flowering heads of ryegrass (Osoro *et al.*, 1993), while tending to reject clover, favouring accumulation of the latter in the upper levels of the sward structure (Del Pozo *et al.*, 1997a,b) (Figure 6). For this reason, ryegrass/clover pastures that are sequentially or mixed-grazed by goats, will have a greater energy and protein content, and enable an increase in the productivity of the other herbivore species present, such as sheep (Del Pozo *et al.*, 1998) or cattle (Osoro *et al.*, 1997b).

Plant communities of *Agrostis/Festuca/Nardus/Calluna*

These plant communities are abundant in the mountains of northern Spain and other regions of similar climate and soil. As with heath-gorse, the animal and plant responses obtained vary considerably in relation to the availability of vegetation and the animal species and breed. Research undertaken by IEPA (Asturias, Spain) provides evidence that in general sheep are more productive on such grasslands than cattle. When the height of palatable grasses (*Agrostis-Festuca*) reaches about 5 cm, liveweight gain achieved by cattle tends to be equal to that of sheep. As the availability of palatable species declines, and cover of *Calluna vulgaris* increases, so the differences in productivity become more marked, in favour of sheep (Figure 7). Within each species, significant differences have been observed in the productive response of different-sized breeds. Smaller breeds have greater production and efficiency when kept under conditions of limited availability of palatable grasses, as shown in Figures 8 and 9 for sheep (Osoro *et al.*, 1999a) and cattle (Osoro *et al.*, 1999b) respectively.

When the height of palatable species is between 3.5 - 4.0 cm, this seems to cancel out differences in efficiency arising from size. Above 4.0 cm, larger breeds begin to demonstrate their potential for ingestion and liveweight recovery, especially in the case of the sheep. Availability of palatable grass above a height of 4.0 cm is usually infrequent in mountain grassland, but all cases occur at the start of the grazing season.

These mountain grasslands do not show large changes in botanical composition, at least over periods shorter than 5 years, in response to grazing by sheep or cattle (Common *et al.*, 1991; Celaya, 1998). In herbaceous swards, the least desirable change is the proliferation of *Nardus stricta* which is stimulated by sheep grazing, and restricted by cattle, also observed by Grant *et al.* (1985). *Nardus* has low nutritional quality and palatability, but is reduced significantly above a certain level of grazing pressure. *Nardus* accumulation, obviously greater in the absence of grazing, appears to lead in winter in mountain areas to increased risk of avalanches. In scrubland dominated by *Calluna*, the dynamics are seen to be more affected by cattle grazing than by sheep even though the latter have higher ingestion of *Calluna* shoots (Oliván & Osoro, 1996). This is due to the greater element of direct damage by trampling caused by cattle (Hodgson & Grant, 1981; Celaya, 1998), which causes a more rapid increase in colonising herbaceous species, though, as explained above, the productive response of sheep on such vegetation is still greater than that of cattle. Broom (*Genista* spp.) is also often found in this vegetation, and is commonly seen to be intensively grazed by sheep, though rarely by cattle.

Level of CAP compensatory payments

Having described some of the limitations to the development of animal production systems, these can now be seen in relation to the levels of compensatory payments under the Common Agricultural Policy (CAP) pertaining to suckler cow systems in LFAs. Three suckler systems were compared: autumn-calving lowland suckler cows; winter-calving lowland suckler cows with transhumance to summer mountain grazing, and winter-calving suckler cows permanently on the mountains (800-1,000 m.a.s.l.). The animal production responses obtained, both per head and per unit area, were significantly different, just as the costs of feeding during periods of shortage differed (Table 5), benefiting most the lowland farms. Evaluating production less the costs of feeding, it was found that the lowland systems was three times more productive in comparison with those situated in more disadvantaged systems (Table 6). Curiously, the current support measures under the CAP, instead of compensating enterprises in the most disadvantaged regions as is their intention, continue to favour those enterprises located in the least disadvantaged regions that can stock a higher number of suckler cows. In order to achieve the stated objective of improving the income of the most disadvantaged enterprises, it would be necessary to reform the system of compensatory aid. Implementation of such a reform should take place at an administrative level corresponding to aggregations of minicipalities so that differences within disadvantaged areas, and the externalities of different areas can be taken into account.

In the case of the small ruminants, differences arising from the location of the enterprise and the available grazing resources are less than is the case for cattle. However, the census of small ruminants over the course of this century has shown a dramatic reduction of sheep and goats in Galicia and Asturias, while the numbers of suckler cows have increased strongly in number, during the last 5-10 years. Galicia and Asturias are LFA regions which have serious environmental, social and economic problems caused by fires, the crisis in industry, and the level of rural exodus where milk production has ceased to be a monthly source of income. This situation calls for a reform and reorientation of livestock husbandry and of agricultural policy with the aim of avoiding rural depopulation and the desertification of extensive areas.

The observations from the present work allow the conclusion that in the development of sustainable systems on marginal lands careful consideration should be given to the smaller livestock species, and within a species, the smaller breeds of cattle, sheep and goats to exploit the significant differences in behaviour and animal productivity under the conditions of the more disadvantaged areas of the Iberian peninsula.

Goats are most appropriate for the control of biomass in

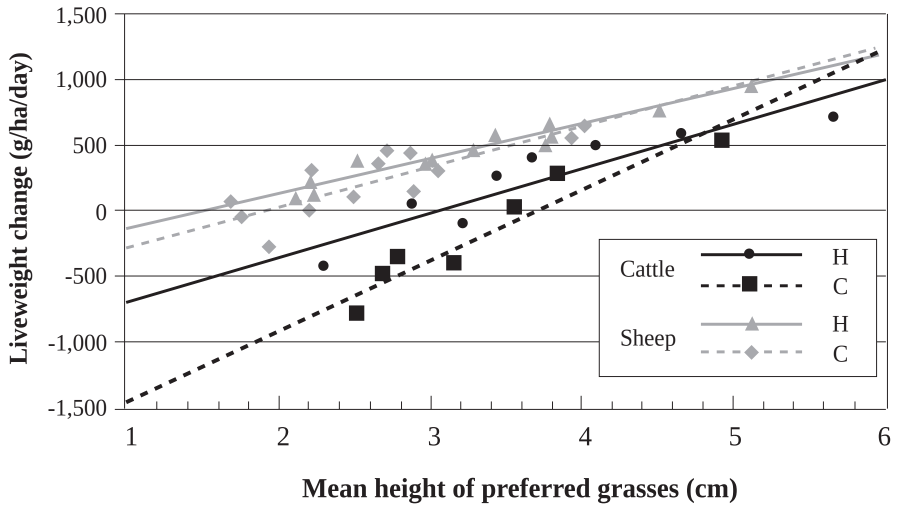

Figure 7. Productivity of cattle and sheep in vegetation dominated by herbaceous (*Agrostis* - *Festuca*) vegetation (H), or *Calluna* (C).

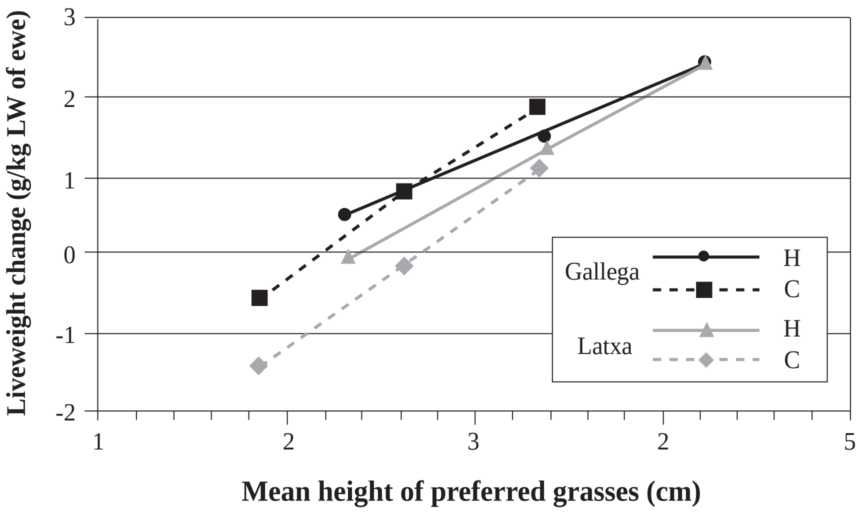

Figure 8. Liveweight changes of two breeds of sheep (Gallega and Latxa) according to their liveweight and the sward height of preferred grasses in vegetation dominated by herbaceous vegetation (H) or *Calluna* (C).

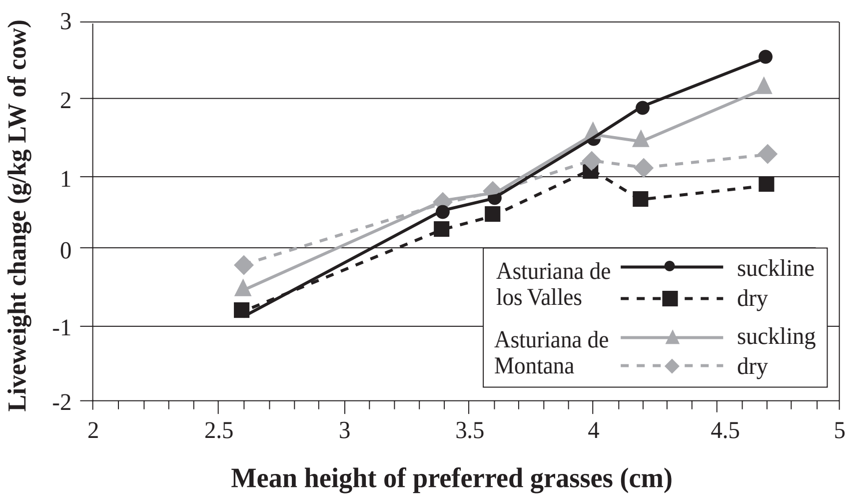

Figure 9. Liveweight changes of two breeds of cattle (Asturiana de los Valles and Asturiana de la Montana) according to their live weight, physiological status and the mean height of preferred grasses.

Table 5. Productivity of different suckler cows systems according to their location.

	LOCATION		
	Lowland(1)	Lowland-Upland(2)	Upland(2)
Stocking rate (cows/ha)	2	2	1.25
Calves: live weight at weaning (kg/ha)	480	345	198
Cow: liveweight increases (kg/cow)	126	127	75
Wintering period:			
Days	90	70	150
Requirements (MJ ME/cow)	9,000	5,600	11,250
Body reserves contribution (MJ ME/cow)	3,391	2,003	3,364
Balance (MJ ME/cow)	-5,636	-2,209	-9,247
Cost of winter feeding (Euros/ha)	180	70	185

*Cost of 100 MJME....1.6 Euros. (1) Autumn-calving cows. (2) Spring-calving cows.

Table 6. Productivity and subsidies from different suckler cows systems according to their location and extensification.

	LOCATION		
	Lowland	Lowland-Upland	Upland
Production/ha (Euros)	1,019	826	474
Winter feeding cost (Euros/ha)	180	70	185
Difference in Gross Margin (Euros/ha)(1)	839	756	285
	554	471	0
Subsidies (Euros/ha):			
Suckler cow	338	338	211
Extensification rate (less 1.4 cow/ha)			56
Total subsidy	338	338	267
Total Upland compensation: 645 Euros/Farm			

(1) Based on upland system.

heath/gorse in those areas most at risk from fires. The presence of sheep in the herd should be in proportion to the presence of herbaceous vegetation. In spite of the sharp population rise indicated by the census, beef cattle have less potential on such land. Comparison of incomes indicates that current levels of compensatory payments are insufficient to compensate those enterprises in the most disadvantaged areas. These latter farms can only be economically sustainable when they have the possibility to cover large areas and have big herds, currently impossible given the current situation where land ownership and livestock farming are both undertaken on a small scale, and the management of mountains for public and neighbourhood use leaves much to be desired in the majority of cases.

The results point to the necessity for technical modernisation of extensive production systems, utilising inputs that contribute both to economic and environmental sustainability and consequently to rural development.

Conclusions

The information presented above allows the potential and limits to the establishment of animal production systems in disadvantaged areas to be evaluated. It also allows an evaluation of the role of extensive livestock, not only for the wealth that quality eco-labelled primary production may generate, but also for their contribution to environmental and ecosystem sustainability that in some of the LFAs of the Mediterranean states is deteriorating rapidly.

Suggested priorities for action are:

1. Re-identification and quantification of the role of extensive livestock in the creation of employment, production of quality products and the conservation of the environment.
2. Reconsideration of the current criteria for compensation that in no way offset the poor productive conditions in the disadvantaged regions.
3. Promotion of techniques of extensive management that allow the economic and environmental sustainability, though they suppose the incorporation of some inputs.
4. The discussion and identification of the different lines and actions to act as incentives to encourage the development of these disadvantaged regions characterised by their heterogeneity.

5. The discussion and evaluation of the contribution of current genetic improvement programmes to the sustainability of extensive systems in disadvantaged regions.
6. The analysis of the limitations imposed by land ownership, ownership structures and the management of land use for the development of disadvantaged regions.
7. Education of farmers in the management of extensive systems.
8. Establishment of channels for the processing and marketing of quality products from the disadvantaged regions.
9. Discussion of the reasons (forestry policy, predators etc.) for discrepancies between the optimal development trajectory, and that observed in reality (for example, the increasing cattle population and shrinking small ruminant sector).
10. Preparation of a strategic plan identifying the strengths, weaknesses, constraints and opportunities of the extensive livestock systems and a typology for areas of rural development.

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