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South European grazing lands: production, environment and landscape management aspects.

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Abstract

Grazing-lands and their management in livestock systems are a matter of special importance in search for sustainability. Sociological and ecological objectives should be considered jointly to animal production development. In addition to the general issues of biodiversity and habitat preservation, the challenges for their management vary according to the regional conditions. In South European environments, where the past changes in livestock farming led to a general decrease in their use, the questions under study are to find the ways to meet the threats for landscape amenity, biodiversity and the sustainability of local animal feeding resource. Grazing lands and their management is also an important target of EU agri-environmental policy. The multifunctional use of this land, which nowadays is searched for, reinforce the need for animal scientists to consider the use and management of grazing-lands in reference not only to the techno-economical efficiency of animal feeding systems, but also in reference to the long term (e.g. biodiversity change) and larger spatial levels (landscape, watershed). An overview of the current challenges attached to grazing-lands and their management in livestock farming systems in South European environments, and an understanding of the ways to meet jointly production objectives and the realisation of sociological and ecological functions is presented.

Introduction

A wide variation in farming systems exists between countries and regions of Europe. This is truer for ruminant systems and their wide diversity is due to being very much tied to physical conditions, which vary widely by climate, soil type, altitude and landscape. Moreover, diversity derives from history, local socio-economics as well as the production and trading chains that have been developed locally. Nevertheless, similarities among broader European areas allow for comparisons, where South European areas are characteristic.

Recent political priorities in Europe aim at rationalizing agricultural production, reduce pollution, upgrade the environment, maintain rural infrastructures and meet new societal concerns such as product quality and animal welfare. These radical policy changes seriously challenge the existing management approaches in agriculture and more specifically in animal farming. Moreover, social trends like human

concentration into civil centers and the increasing use of modern civil industrial facilities result in the abandonment of farming on the remote areas, while periurban areas experience strong farming intensification. Therefore the search for sustainability, which covers all economic, social and environmental aspects of agriculture, is now taking a new boost. In the heart of this search, grazing-lands and their management in livestock systems are a matter of special importance for animal production. Grazing-lands, besides commodity production, support environmental, economic and social functions beyond the farm context. These include the maintenance of biodiversity, landscape – soil – air and water quality, recreation, rural employment and social benefits. These aspects are increasingly attracting attention in research and in society since grazing-lands cannot be considered in isolation from other components of the farming system or from externalities such as society's cultural values, which impinge on farming (Pearson and Ison, 1997).

Grazing-lands in South Europe

Grazing-lands in the South European countries, which are used mainly for extensive animal farming, represent a significant proportion of their total land. These areas have been interacting with human and livestock practices for millennia. Pflimlin and Todorov (2003) summarized and categorized the Eurostat Census 2000 data (Table 1) to present figures for land use, livestock numbers and livestock holdings for the 15 EU countries and their distribution over five distinct geographical livestock zones. The zone of the Mediterranean regions includes the south and central Iberian peninsula, the French Mediterranean, the central and southern Italy and the southern Balkans. There the large rangelands are used mainly for sheep, goats and cattle farming. Permanent and temporary grasslands together with forage crop areas represent 44% of the UAA in the Mediterranean regions, these not always including rough-grazings. In Greece for example, according to the National Statistics Service, further to the 29% of arable land, a 40% of the total land area is classified as rough grazings, of which 83% is located in mountainous and semi-mountainous regions (Hadjigeorgiou et al., 2002). A similar pattern appears in Portugal, where agricultural land is 41% and grazing-lands 22% of the total land used.

Table 1. Land use and livestock in Europe (EU15, 2000): distribution between geographical zones (%) and total figures (×1000), (after Eurostat Census 2000).

European	------- Land Use ------			-------- Livestock --------				------ Holdings ------		
Geographical Zones	total UAA	PG	TG+FG	dairy	beef	ewes	goats	total	---- LFA ------ mount.	others
Wet mountain regions	7	13	7	12	12	4	7	21	42	12
Mediterranean regions	36	30	14	12	18	51	83	30	45	26
Grassland plains reg.	19	36	24	29	37	34	2	18	1	27
Forage cropping reg.	28	19	39	40	27	9	7	26	7	30
Northern regions	4	-	12	4	2	-	-	3	5	4
Crop regions	1	2	4	3	4	2	1	2	-	1
Total EU-15 (×1000)	126,713	44,558	12,930	20,578	11,951	69,325	9,387	2,320	700	732

Abbreviations: UAA: Utilized Agricultural Area; PG: Permanent Grassland; TG+FG: Temporary Grassland + Forage Crops; LFA: Less Favoured Areas.

South European countries experience particular climatic conditions (e.g. pronounced drought in the summer, short periods of precipitation, mainly in winter, a wide temperature range etc), which influences the location and timing of grazing practices

(Peco, B., 2002). Moreover, high altitudes, steep slopes, exposed ground and poor soils characterize the topography of the South European grazing land areas. Superimposed on these physical characteristics are remoteness from civil centers and a pattern of land use primarily consisting of extensive agriculture and forestry (Pflimlin and Todorov, 2003). Climate, slope and soil conditions are major factors governing the patterns of vegetation growth, the vegetation itself and the land use in any single rangeland area. The spatial and temporal diversity contributes to biodiversity and favors the application of different agricultural systems (these including crops and animal farming).

Grazing lands for commodity products.

According to the Hellenic National Statistics Service, about 2.4 million Livestock Units (LU) of domestic herbivore animals, potentially using grazing lands, (this including suckler cows, equidae, sheep and goats), are utilizing the 5.2 million ha of rough grazings in Greece, along with the 3.2 million ha of arable land (cereal stubble, olive tree grooves etc) which are occasionally grazed. These animals are distributed relatively homogeneously on the Greek territory with the average elementary administrative unit ("Kinotita") having an animal population of 400 L.U. Moreover, these animals are registered in "Kinotitas" having bellow average, average and above average population of animals by 27.3, 33.3 and 39.4 % respectively. However, the distribution of grazing animals in relation to the available rough grazing land area of each "Kinotita" follows a different pattern with the majority of the areas (73%) receiving low stocking densities (<0.5 LU ha^{-1}). Similarly to Greece, Portugal records an average stocking density of 0.5 LU ha^{-1} of animals kept on pasture over the year.

These animals rely on pasture for their feeding to a varying degree, which in the case of Greece, for those animals grazed was found to range from 25 to 75 % of their total annual requirements. This diversity was mainly due to grazing land productivity and the management system applied by farmers.

Features of the rough grazing lands in South European countries include a high percentage of annuals, whereas, soil heterogeneity reinforces the remarkable level of species richness that characterizes this vegetation. In Portugal as an example, the seed-bank of natural annual pastures was estimated for an area of 18 ha (Almeida, 2002). The investigation revealed that there were 583 seeds m^{-2} (s.d. 460) with an average weight of 409 mg 1000^{-1} seeds (s.d. 809), which result in 155 kg seed ha^{-1} (s.d. 169 kg). This richness and variability is probably the result of a high spatial and temporal diversity linked to the soil and climate conditions, grazing by domestic and wild animals and other human-induced grassland management activities and is responsible for the high level of plant community adaptation (Almeida, 2002).

Management practices can influence soil-seed bank dynamics and therefore pasture production level. In Portugal, as an example, the intensification of pasture production increased herbage production from 3455 kg DM ha^{-1} $year^{-1}$ (on natural pastures), to 4986 kg DM ha^{-1} $year^{-1}$ (on highly fertilized indigenous pastures) and 6283 kg DM ha^{-1} $year^{-1}$ (on subterranean clover sown and highly fertilized swards). However, plant biodiversity decreased from 107.909 seeds m^{-2} (natural pastures) to 50.325 seeds m^{-2} (high fertilization) and 32.899 seeds m^{-2} (subterranean clover and high fertilization),

which are expected to result to a decrease in adaptation capacity to the extreme climatic variations (Almeida and Fernandes, 1990; Almeida, 2002).

Plant species diversity of South European grazing-lands is contributing to distinct quality of animal products from these regions (Boyazoglu and Morand-Fehr, 2001). In these areas open-air grazing can be practiced all over the year and represents a very important intrinsic resource that should be fully exploited, since it has marked positive direct effects (high carotene content improves milk, butter and cheese colour) and indirect ones (proteolytic enzymes influence cheese maturation and texture) on several traits of animal products. Among the compounds that can be directly transferred from pasture to animal tissues are the terpenes, present in herb-rich grassland swards. Flavonoids and phenolic acids are also present in natural pastures and they are known for their influence on the taste of foods as well as for their medicinal properties, which improve the health of the consumer. This is also the case for some fatty acids (polyunsaturated, conjugated linoleic acid etc), which are claimed to have anti-teratogenic or anti-carcinogenic role for the consumers. An important aspect could be the possibility to relate botanical composition of the animal diet with the final products and therefore to be able to identify products from different areas and valorize them (Porqueddu, et al., 2003).

Grazing ruminants can benefit by the inclusion in their diet of forage legumes containing condensed tannins (up to 5%) as they can reduce bloat, improve nitrogen utilization, amino-acid absorption in the small intestine and finally overall animal production (Porqueddu, et al., 2003). These components can also reduce intestinal parasite burdens and attacks of flies in grazing animals, thus decreasing the need for synthetic medicine. Other plants contain a variety of secondary compounds, which can act as natural antibiotics, for example *Plantago lanceolata* contains *aucubin*, which has been found to have positive effects on livestock health and negative influence on silage fermentation. These natural compounds can obviously help the development of "organic" farming by reducing the need for synthetic medicines (Porqueddu, et al., 2003).

Grazing lands for the environment.

Increasingly recognized are other functions of grazing lands and these areas are often claimed for purposes of recreation, water supply, nature conservation, military use and mineral extraction. These areas also comprise important wildlife habitats and countryside of outstanding natural beauty, since they are by no means uniform.

Herbivores are generally regarded as disturbance generators due to their consumption of plants or plant parts such as leaves, fruit, seeds and roots, their mechanical disturbance of soil (trampling, grubbing etc) and other changes to earth features due to dung deposition. However, the use of herbivores as tools for environmental and landscape management has recently being recognized (Moulin and Guerin, 2002). Due to their management (large herds, directed herding, supplement feeding) domestic animals may impose a different grazing pressure than the wild herbivores. Moreover, the grazing behaviour of domestic animals on the open (unfenced) grasslands is very close to natural, unlikely that in enclosed fields. As an effect the domestic animals are replicating the grazing patterns of herds of wild grazers, which used to roam across the European landscape in the long distant past. Which plants

grow where, their relative abundance and how prolifically they can flower is to a large extent determined by the behaviour of grazing animals (by what they eat, when they eat it and how frequently they return to the same spot to feed).

There is still a gap in our knowledge to predict the vegetation response to grazing pressure in terms of plant species richness (Leger et al., 2002). Herbivores are generally thought to increase species richness, although some studies suggest a weak or even negative effect. Both at the patch and community scale, Grime (1979) postulated a now widely accepted bell-shaped relationship between plant species diversity and grazing pressure. High and low grazing pressures produce few plant species whilst intermediate grazing intensities lead to maximum species diversity. Even under conditions of heavy grazing, vegetation diversity is not affected adversely, but changes in the composition of the community are generated (Perevolotsky et al., 2002). On the contrary pastures that have been abandoned are often encroached by simple shrubby vegetation with a result in reduced biodiversity (Stagliano, N. et al., 2003).

In a study carried out in Central Greece the herbaceous vegetation of four grazing-land areas (Mi, Da, Bl, Ka) differing mainly in grazing management practices was studied. These four areas had various characteristics, presented in Table 2, in terms of elevation from sea level, the available pasture areas, herbage productivity, livestock units in the area utilizing the grazing material (sheep, goats and some cattle) and the patterns of pasture utilization expressed as proportion of the year the animals grazing this area.

Table 2. Basic grazing-land characteristics of four areas studied in Central Greece.

AREA	Elevation (m a.s.l.)	Pasture area (ha)	Herbage productivity (kg DM ha^{-1} $year^{-1}$)	Stocking density (LU ha^{-1})	Grazing coefficient
Mi	175	2,090	3,765	0.32	0.494
Da	150	11,970	3,413	0.56	0.948
Bl	250	2,600	3,832	0.64	0.845
Ka	535	1,400	2,855	1.23	0.718

Botanical analysis at the end of annual plants life (end of June) was used to calculate the following diversity indexes for each area : 1) Plant density (tillers m^{-2}), 2) Species richness (N), 3)Shannon-Wiener diversity index (H), 4) Evenness (E) index, ranging between 0 and 1, where 1 means complete evenness, 5) Simpson dominance index (D), which had the values presented in Table 3.

Table 3. Botanical composition diversity of four grazing-land areas studied in Central Greece, expressed through various diversity indexes.

AREA	Plant density (tillers m^{-2})	Species richness (N)	Shannon (H) index	Evenness (E) index	Simpson (D) index
Mi	486 ab *	8 a	0.186 a	0.656 a	1.353 a
Da	473 a	18 b	0.405 b	0.793 a	2.989 b
Bl	528 ab	20 b	0.375 b	0.683 a	2.696 ab
Ka	806 b	24 b	0.343 ab	0.596 a	3.172 b

*means within each column followed by different letters differ at the $P<0.05$ level.

These data support the suggestion that areas receiving low grazing pressure for a fraction of the year are more likely to have a reduced plant diversity as compared to areas receiving moderate pressure throughout the year.

Moreover, the foraging behaviour of the farmed ruminants is important in determining which plant communities are grazed and in what seasons. An example of the differences in grazing behaviour between species and the contrasting effects they can create on vegetation comes from Spain where sheep and goats grazed the same initial vegetation mix of shrubs and herbaceous species for a period of two years. It is clearly illustrated in Figure 1, that goats grazing had reduced the proportion of shrubs, to the benefit of herbaceous vegetation, relative to that of sheep grazing even after following sheep in grazing the plots.

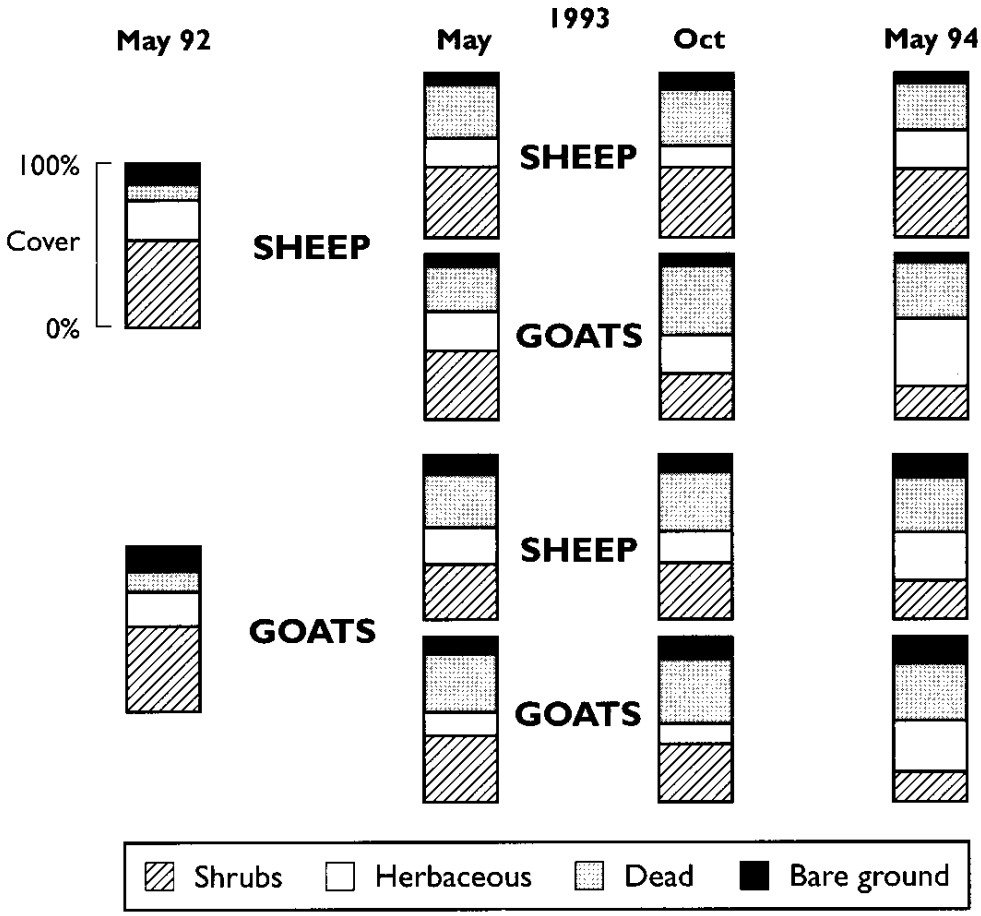

Figure 1. Evolution of the canopy cover in heathlands grazed by sheep or goats in Spain. (Celaya & Osoro, 1997)

However, vegetation composition in plant species is not the only aspect affected by grazing pressure. Consumption of plant biomass accumulated in grazing lands is deterring the ignition and stops the spreading of wild fires, which often lit spontaneously in Mediterranean environments. This same effect of opening the vegetation is aiding the creation of ideal biotopes for a range of life forms like: invertebrates, insects (some of them very spectacular like butterflies), birds, reptiles

and small mammals. Grazing pressures, which create maximum plant species diversity in grasslands is also leading to other species diversity, particularly of the phytophages and predators. The impacts of large herbivore densities on bird and mammal populations can be various. The balance between grassland, scrubland and woodland can be important for a whole range of species in providing appropriate feeding and nesting sites. Reduced numbers of domestic livestock will reduce the amount of prey and carrion from domestic animals as well as the amounts of deposited dung. Grazers' role as dispersers of viable seeds was a less documented aspect until quite recently. Dung can play an important role in the life cycle of mainly annual plants since it provides good conditions for seeds that have passed through their digestive system to germinate and establish new generations of plants. These seeds may have traveled for hundreds of kilometers in the animals' digestive system or on their skin coat.

Grazing lands for the landscape.

Agricultural intensification and land abandonment are the principal threats to semi-natural pastoral landscapes. For example, the decline of over 200 threatened plant species has been attributed to abandonment, while of the 195 bird species of European Conservation Concern, over 20% are threatened by agricultural intensification and over 40% by agricultural abandonment (McCracken and Bignal, 1995).

In a Greek study Ispikoudis and Chouvardas, (2003) investigated changes in the area of Portaikos Valley, in Pindus Mountain (Central Greece) which occupies an area of 12,450 Ha by using Geographic Informational Systems (GIS) for mapping of land cover/use changes on three sequential series of airphotographs (1945, 1960 and 1992). Between 1945 and 1992, cultivated land decreased by 46,72%, grassland by 31.78% and shrubland by 10.55%. On the contrary coniferous forests increased by 17.40% and broad-leaved forests by 23.31%, while a significant shift from sparser to denser forest was observed. This was associated with a reduction to the total number of inhabitants in the seven small communities of the study area (34.3% between 1951 – 1991), while those employed in the primary sector (agriculture, forestry, etc.), decreased dramatically from 39.21% of the economical active population in 1961 to 9.19% in 1991.

Grazers, both domesticated and wild have a major impact on the vegetation composition, vegetation structure and the species composition. The effects of grazing on the plants that are eaten produce diverse structures of vegetation. All these grazing induced variations in the height, density and types of vegetation make up a landscape. For instance the subtle patterning of textures and colors of the herbage vegetation that can be seen from a distance shapes the landscape together with flowering plants of different color flowers and flowering times. As agriculture is the major land-using activity in the Mediterranean basin, its impact on landscape is significant (Parris, 2002). Agricultural landscapes are the visible outcome from the interactions between agriculture, natural resources and the environment. From this point of view the existence of a variety of vegetation types favors the South European countries. However, since landscapes are not valued in monetary terms, the challenge for society is to judge the appropriate provision of landscape. Moreover, there is a need to assess which landscape features society values and to examine to what extent policy changes affect agricultural landscape.

Conclusions

Grazing lands in Southern Europe are an important element in livestock farming systems. However, they equally play a significant role in environmental conservation, where they constitute a basic feature of landscape and can be used to upgrade it. It can reasonably be claimed that production objectives can be jointly achieved with social and ecological functions of grazing-lands, hence animal scientists should consider the use and management of grazing lands not only in terms of short term techno-economical efficiency, but in reference to the long term and larger spatial levels.

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