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Southern European grazing lands: Production, environmental and landscape management aspects

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Abstract

Grazing lands and their management in livestock systems are a matter of special importance in the search for sustainability. Socio-economic and ecological objectives should be considered jointly in considering livestock production. In addition to the general issues of biodiversity and habitat preservation, the challenges for their management vary according to the regional conditions. In Southern European environments, where the past changes in livestock farming have led to a general decrease in their use, the questions under study are how to find ways to meet the threats to landscape amenity, biodiversity, the sustainability of local animal feeding resources and the rural population. Grazing lands and their management is also an important target of EU agri-environmental policy. The multifunctional use of this land, which is currently sought, reinforces 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 at larger spatial scales (for example the landscape and watershed). An overview of the current challenges attached to grazing lands and their management in livestock farming systems in South European environments, an understanding of the ways to jointly meet production objectives and the realisation of sociological and ecological functions is presented.

Keywords: Southern Europe; Grazing land; Livestock systems; Conservation; Biodiversity

1. Introduction

Recent political priorities in Europe aim to rationalize agricultural production, reduce pollution, upgrade the environment, maintain rural infrastructures and meet new societal concerns such as product quality and animal welfare (Burtscher, 2004). These radical changes seriously challenge the existing management approaches in agriculture and more specifically in livestock farming. Therefore the search for sustainability, which covers economic, social and environmental aspects of agriculture, is given a new impetus. Grazing lands and their management as live-

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stock production systems are a matter of special importance since they support 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).

The objective of this paper is to offer an overview of the recent findings related to grazing lands and their management in livestock farming systems in South European countries and to contribute towards an understanding of the ways that jointly production objectives and the realisation of sociological and ecological functions can be met.

2. Grazing lands in Southern Europe

Ruminant farming systems are widely diverse due to being very much tied to physical conditions, which vary widely according to climate, soil type, altitude and landscape (Gibon et al., 1999). Furthermore diversity derives from history and local socio-economics as well as the production and trading chains that have been developed locally. However, similarities among broad areas allow for comparisons, where Southern European areas are distinctive.

Grazing lands in Southern European countries, used mainly for extensive livestock farming, represent a significant proportion of the total land area. These areas have been interacting with human and livestock practices for millennia. Pflimlin and Todorov (2003) summarized and categorized the Eurostat Census 2000 data for the 15 EU countries to present figures for land use, livestock numbers, livestock holdings and their distribution over five distinct geographical zones. The Mediterranean mountain zone (literally the South European countries) accounted for 0.36 of the total Utilized Agricultural Area (UAA) and 0.26 of the total EU forage production area. There, the farming of 0.51, 0.83 and 0.18 of the total EU sheep, goats and beef cattle populations is practiced, in a large number of holdings (0.30 of EU total), half of which are on mountainous Less Favoured Areas (LFA) (Pflimlin and Todorov, 2003). Although the forage production area accounts for 0.26 of the UAA in the Mediterranean mountainous regions, these do not always include rough grazings. In Greece, for example, according to National Statistics Service, 0.40 of the total land area is classified as rough grazings (Hadjigeorgiou et al., 2002), while in Spain the corresponding area accounts for 0.375 of the total area (MAPA, 2002).

Southern European countries experience particular climatic conditions (e.g. pronounced drought in summer, short periods of precipitation in winter and a wide temperature range), which influence the location and timing of grazing practices (Peco, 2002). Moreover, high altitude, steep slopes, exposed ground and poor soils characterize the topography of Southern European grazing land areas. Superimposed on these physical characteristics are remoteness from towns 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. This diversity contributes to biodiversity and favours the application of different agricultural systems (including a combination of crops and multi-specific livestock farming).

3. Grazing lands for commodity products

According to the Hellenic National Statistics Service, about 2.4 million Livestock Units (LU) of domestic herbivores, potentially use grazing lands (this including suckler cows, equidae, sheep and goats). They utilize 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. The livestock are distributed relatively homogeneously on the Greek territory, where the average basic regional administrative unit ("Kinotita") hosts a population of 400 LU. 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, Spain and Portugal records an average stocking density of 0.3 and 0.5 LU ha^{-1}, respectively, of animals kept on pasture over the year.

In Italy the area devoted to permanent pastures amounts to c.a. 3.8 million ha that represents 52% of the total forage area. This is the basic feed resource for around 2.4 million LU (ISMEA, 2003). The annual stocking rate varies between regions and areas within regions, ranging from 2 to 0.01 LU ha^{-1}. For instance in Sardinia the main livestock (dairy sheep, c.a. 3.5 million heads) graze the irrigated lowlands at 10–20 ewes ha^{-1} where annual forage crops and perennial forage pastures (white clover mixtures and lucerne) are grown, but natural pastures in the hilly inner areas are stocked at 1–3 ewes ha^{-1} (Molle et al., 2002).

Grazing animals rely on pasture for their feeding to a varying degree, which in Greece was found to range from 25% to 75% of their total annual requirements (Zervas, 1998; Zervas et al., 1999). This diversity is mainly due to the productivity of the grazing land and the management system applied by farmers, two factors that are often strongly associated. For instance, dairy sheep management in Mediterranean countries ranges from continuous stocking in self-reseeding annual plant pastures, featured by prostrate habit of growth and producing 1–5 t DM ha^{-1}, to rotational grazing or even strip-grazing of annual forage crops with upright habit of growth producing 5–10 t DM ha^{-1} (Molle et al., 2002).

There have been few studies on the management of pasture mixtures, which have an outstanding importance for Mediterranean area. As for grass-based monocultures, guidelines for the management of Italian ryegrass pastures stocked continuously by dairy sheep have been set up using compressed sward height as a reference (Molle et al., 2002). Grass–legume mixtures as well as legume monocultures usually provide greater individual and, sometimes, per unit area performance than grass monocultures as reviewed for cattle and sheep by Rochon et al. (2004). Pastures based on self-regenerating species (*Medicago polymorpha*, *Trifolium subterraneum*, and *Lolium rigidum* Gaudin) were studied either continuously stocked or rotationally grazed by dairy sheep at a stocking rate of 6 ewes ha^{-1} over two grazing seasons. Results did not show any marked advantage for the latter system in terms of both pasture production and milk yield (Sitzia et al., 1996). Pasture management has been thoroughly re-evaluated by Meuret (1997) for browsing small ruminants and, to some extent, by Molle et al. (2003) who focused on sheep grazing legume and grass monocultures. These studies underline the role of high-quality forage, such as legumes, as an "appetite booster" but the latter study also showed that, if the legume pasture contains moderate levels of condensed tannins, the effect is short-lived.

Grazing ruminants can benefit by the inclusion in their diet of forage legumes containing up to 5% condensed tannins as they can reduce bloat and improve nitrogen utilization by increasing amino-acid absorption (Barry, 2001). These components can also reduce intestinal parasite burdens and attacks of flies in grazing animals, thus decreasing the need for synthetic medicinal products, and as a consequence support the development of "organic" farming (Porqueddu et al., 2003; Nardone et al., 2004). Plants also contain secondary compounds, which can act as natural antibiotics. The essential oils of three *Achillea* species and those of *Satureja, Origanum* and *Thymus* species were found to have antibacterial activity (Magiatis et al., 2002; Chorianopoulos et al., 2004) on foodborne pathogens. Moreover, a few hours of daily grazing on natural pastures under conventional farming schemes, can improve the immune (non-specific) function of dairy sheep (Hadjigeorgiou and Politis, 2004).

Plant species diversity of South European grazing lands can contribute to the distinct quality of animal products from these regions (Boyazoglu and Morand-Fehr, 2001). In these areas grazing can be practiced year round and represents an important intrinsic resource that could be more fully exploited, since it has markedly positive direct (e.g. high carotene content improves milk, butter and cheese colour particularly in cattle) and indirect (e.g. proteolytic enzymes influence cheese maturation and texture) effects on several traits of animal products. An important aspect could be the possibility to relate botanical composition of the animal diet with the final product and therefore to be able to identify and accredit them (Prache et al., 2003). 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 can putatively improve

the health of the consumer (Adams, 1999). Moreover grazed herbage, particularly at the vegetative phase (Dewhurst et al., 2001) is particularly rich in poly-unsaturated fatty acids, which can directly or indirectly (after rumen biohydrogenation) be transferred into dairy produce. Linolenic acid as well as other $n-3$ fatty acids and conjugated linoleic acid are all evoked as putatively beneficial components of the diet of consumers since they may have potential anti-atherogenic or anti-carcinogenic effects (Chilliard et al., 2000).

Although the above positive effects of grazing on product quality push towards a re-evaluation of the role of grazing in the livestock production of southern Europe, several counter effects prevent a wider implementation of grazing. A key shortcoming is that the maximum sustainable stocking rate is often not economic (Hadjigeorgiou et al., 2002), since the high quality of products is usually not mirrored in their prices. Nevertheless, there are additional roles that grazing land can play that can make them economically viable in the future. Increasingly recognized are the roles of recreation, water supply, nature conservation, military use and mineral extraction functions. These areas also comprise important wildlife habitats and countryside of outstanding natural beauty, since they are by no means uniform.

4. The environmental role of grazing lands

Herbivores are generally regarded as disturbance generators due to their consumption of plants or plant parts, such as leaves, fruits, seeds and roots, their mechanical disturbance of soil (trampling, grubbing etc) and other changes to the function of soils due to dung deposition. However, the use of herbivores as tools for environmental and landscape management has only recently being recognized (Milne and Osoro, 1997; Moulin and Guerin, 2002). Due to their management (large herds, managed herding and supplementary feeding) livestock may impose different grazing pressures than wild herbivores. However, the grazing behaviour of livestock on the unfenced grazings is very close to wild herbivores, unlike that in enclosed fields. 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 through what they eat, when they eat it and how frequently they return to the same site to feed (Rook et al., 2004).

Features of the rough grazing lands in Southern European countries include a high proportion of annuals, whereas, soil heterogeneity reinforces the remarkable level of species richness that characterizes this vegetation. 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. The seed-bank of natural annual pastures was estimated for an area of 18 ha in Portugal (Almeida, 2002). The investigation revealed that there were 583 seeds m^{-2} with an average weight of 409 mg 1000^{-1} seeds, which result in 155 kg seed ha^{-1}. Rochon et al. (2004) in reviewing the literature on grazed legumes in Mediterranean areas showed that the proportion of self-regenerating legumes in the sward is strictly related to the amount of seed in the seed-bank, which in turn depends on grazing system and grazing intensity. For example, a moderate to high grazing intensity is recommended for burr medic grazed rotationally by sheep and the same applies for self-reseeding annual legumes grazed by beef cattle (Gutman et al., 1999). The intensification of pasture production, in a Portuguese study, resulted in 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, in this study plant biodiversity decreased from 107.9 to 50.3 and 32.9 seeds m^{-2} in natural pastures, high fertilization and subterranean clover plus high fertilization treatments respectively, which are expected to result to a decrease in adaptation capacity to the extreme climatic variations (Almeida and Fernandes, 1990; Almeida, 2002).

There is still a gap in our knowledge to predict the vegetation response to grazing pressure in terms of plant species richness. 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 necessarily affected adversely but changes in the composition of the community are generated (Perevolotsky and Seligman, 1998; Meuret, 2002). On the contrary pastures that have been abandoned are often encroached by simple shrubby vegetation resulting in reduced biodiversity (Stagliano et al., 2003).

The effects of management on grazing behaviour, animal performance and vegetation dynamics have been extensively studied with ruminants on marginal hill lands covered by heather-gorse vegetation (Osoro et al., 1998). Sheep, goats and cattle breeds and grazing management had a significant effect on vegetation (Celaya and Osoro, 1997) by encouraging plant biodiversity in general but the strongest effect was observed under goat grazing (Fig. 1). Moreover, significant differences in vegetation structure (Fig. 2) were observed between plots grazed by either local goats (celtiberic tronc) or exotic ones (cashmere) at low or high stocking rates (Celaya et al., 2004).

The herbaceous vegetation of four areas of grazing land, differing mainly in grazing management practices, was recorded in a Greek study (Hadjigeorgiou and Karalazos, in press). The areas differed in terms of elevation from sea level, the available pasture areas, herbage productivity, grazing load (sheep, goats and some cattle) and the pattern of pasture utilization. Areas receiving low grazing pressure or for a proportion of the year, were more likely to have reduced plant diversity as compared to areas receiving moderate pressure throughout the year (Table 1).

Grazers' role as dispersers of viable seeds was a less documented aspect until quite recently (Peco, 2002). 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 kilometres in the digestive system or on the skin coat.

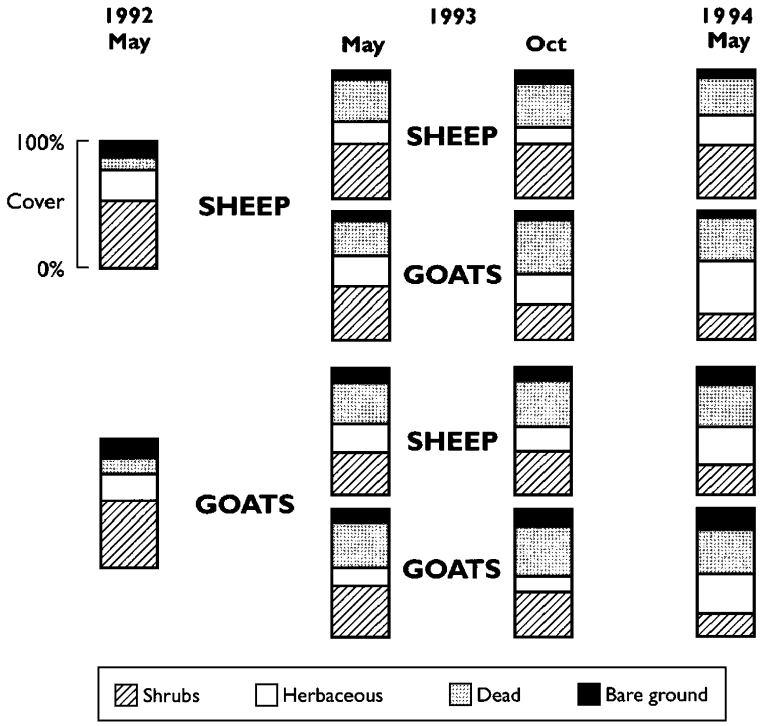

Fig. 1. Changes in the canopy cover in heath lands grazed sequentially by sheep or goats in a two-year period (Celaya and Osoro, 1997).

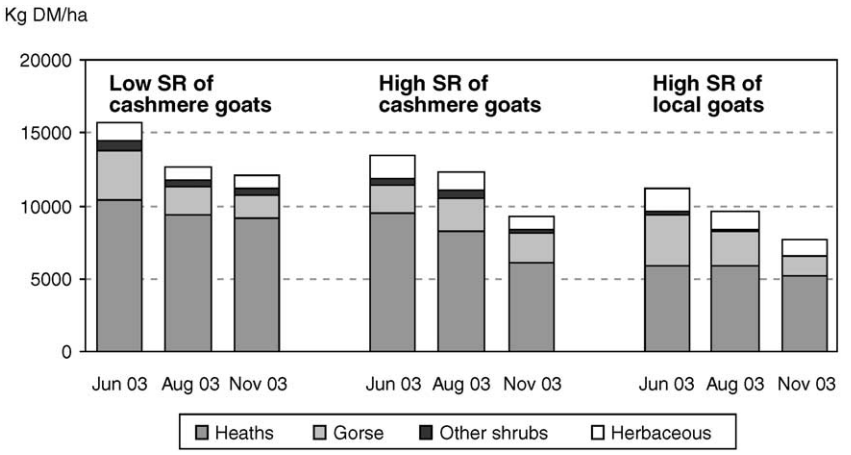

Fig. 2. Changes, within a year, of a heather community aerial biomass, grazed by either local or exotic (cashmere) goats at different stocking rates (values are means from 3 replicates) (Celaya et al., 2004).

However, plant species composition is not the only aspect affected by grazing pressure. Consumption of plant biomass accumulated in grazing lands can deter fires, which often lit spontaneously in Mediterranean environments. This same effect of maintaining an open vegetation canopy can aid the creation of ideal biotopes for a range of life forms such as invertebrates, insects (some of them very spectacular such as butterflies), birds, reptiles and small mammals (Brandmayr et al., 2002). Grazing pressure creating maximum plant species diversity in grasslands can also lead to diversity, particularly of the phytophages and predators (Milne and Osoro, 1997). The impact of large herbivore densities on bird and mammal populations can be variable. The balance between grassland, scrubland and woodland can be important for a whole range of species in providing appropriate feeding and nesting sites. For example reduced numbers of domestic livestock can reduce the amount of prey and carrion from domestic animals as well as the amounts of deposited dung (Brandmayr et al., 2002).

The open structure of the Mediterranean habitats is usually dependent on grazing unless there is an active programme of management or cultivation. The hay meadows, that were once thoroughly maintained as an integral part of the traditional livestock systems, were supporting not only a large variety of plant species but also a vast abundance and diversity of butterflies (Kruess and Tscharntke, 2002). Once the forage is no longer harvested, the area can revert to scrub and then forest, which can also spread up into the alpine grasslands. Most butterfly species feed as larvae on herbaceous plants and grasses. Even those species whose food plants are woody plant species utilize nectar sources provided by flowering herbs growing in the sunny spaces between trees and shrubs (Grill and Cleary, 2003).

Agricultural intensification and land abandonment are currently the principal contrasting trends within

Table 1
Basic characteristics of four grazing lands studied in Central Greece and their botanical diversity, expressed through various indexes (Hadjigeorgiou and Karalazos, in press).

AREA	Elevation (m a.s.l.)	Stocking density (LU/ha)	Presence coefficient	Plant density (tillers/m^2)	Species richness (N)	Shannon index (H)	Simpson index (D)
Mi	175	0.32	0.494	486^{ab}	8^{a}	0.186^{a}	1.353^{a}
Da	150	0.56	0.948	473^{a}	18^{b}	0.405^{b}	2.989^{b}
Bl	250	0.64	0.845	528^{ab}	20^{b}	0.375^{b}	2.696^{ab}
Ka	535	1.23	0.718	916^{b}	24^{b}	0.343^{ab}	3.172^{b}

*Means within each column sharing different letter superscripts differ at the $P<0.05$ level.

the EU (MacDonald et al., 2000), which is likely to have severe implications on biodiversity. The decline of over 200 threatened plant species has been attributed to abandonment, while of the 195 bird species of European Conservation Concern, some 20% are threatened by agricultural intensification and over 40% by agricultural abandonment (McCracken and Bignal, 1995).

5. Landscape role of grazing lands

Agricultural intensification and land abandonment are also the principal threats to semi-natural pastoral landscapes (MacDonald et al., 2000). Ispikoudis and Chouvardas (in press) investigated vegetation changes in an area of the Portaikos Valley (12,450 ha), in Pindus Mountain (Greece), by using Geographic Informational Systems (GIS) to map land cover/use changes on three sequential series of air photographs (1945, 1960 and 1992). Between 1945 and 1992, cultivated land decreased by 0.46, grassland by 0.32 and shrubland by 0.11. Moreover, coniferous tree forests increased by 0.17 and broad-leaf tree forests by 0.23, 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 (0.34 between 1951–1991), while those employed in the primary sector (agriculture, forestry, etc.), decreased dramatically from 0.39 of the economical active population in 1961 to 0.09 in 1991.

A 25-year study recorded the vegetation on an 82 ha mountainous area in Sardinia (Italy) which was grazed by suckler cows at a stocking rate of between 0.5 and 0.9 cows ha^{-1} (Scotti et al., in press). Vegetation cover in the area was dominated by trees, mainly oak species, with a history of local agroforestry practice (coppice) and shrubs intermixed with herbaceous patches. Using both photo-interpretation and in-field measurements, the authors were able to ascertain that cattle grazing had a doubly positive effect since, while providing high levels of animal performance, it allowed for the recovery of the forest after a fire that occurred in 1996.

Grazers, both domesticated and wild, have a major impact on the vegetation composition, vegetation structure and species composition. The effects of grazing on the defoliated plants produce diverse structures of vegetation. Grazing induces variations in the height, density and types of vegetation that make up a landscape. Moreover, the subtle patterning of textures and colours of the herbage vegetation that can be seen from a distance shapes the landscape together with flowering plants of different colours 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 favours the Southern 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 landscapes.

6. Conclusions

In Southern European environments, where current changes in societal structures and the economic environment are threatening the traditional pastoral practices, the questions that require to be answered relate to finding ways to meet the threats to biodiversity, landscape amenity and the sustainability of local livestock systems and the rural population. The multifunctional use of grazing land reinforces the need for animal scientists to consider the use and management of grazing lands not only for techno-economical efficiency of systems but also to the broader benefit of society.

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