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Hadjigeorgiou I., Zervas G.

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Evaluation of production systems in protected areas: Case studies on the Greek "Natura 2000" network

I. Hadjigeorgiou and G. Zervas

Department of Animal Nutrition, Agricultural University of Athens,
75 Iera Odos, GR 118 55, Athens (Greece)

Abstract. The concept of protected areas has been recently introduced in European political priorities, reflecting the interest of Europeans in conserving basic elements of their homeland. The "Natura 2000" network has been the basic institution in this direction. Greece has some 262 areas designated as "Natura 2000" sites covering 18.2% of the total land area, which has been shaped through a very long history of breeding sheep and goats grazing the indigenous vegetation and some relevant shepherds' practices ending up to the present land cover. Two areas traditionally hosting large numbers of grazing sheep and goats and currently designated as "Natura 2000" areas, have been selected for proper management case studies, covering the two most important types of sites: (i) inland and mountainous areas; and (ii) island areas. The first one is part of Arcadia which lies in the center of Peloponnese, where three "Natura 2000" sites exist namely: GR2330002, GR2520001 and GR2530004. The second study area is represented by the Ikaria and Fourni island complex (Eastern Aegean Sea) where three "Natura 2000" areas are also designated: GR4120004, GR4120005 and GR4120006. For the purposes of setting grazing management rules in the areas, the production systems applied in those areas were investigated and a combination of National Statistics, CORINE and field data were used to define system dependence on local grazing resources. Subsequently grazing capacities were determined and advised to the local authorities together with management guidelines with the aim of maintaining the preserved areas under moderate grazing activity.

Keywords. Production systems – Rangeland management – Protected areas – "Natura 2000" – Greece.

Evaluation des systèmes de production en zones protégées : études de cas concernant le réseau grec Natura 2000

Résumé. *Le concept de zone naturelle protégée a été récemment introduit dans les priorités politiques de l'Europe, reflétant l'intérêt des Européens pour la préservation des éléments de base de la nature de leur pays. Le réseau "Natura 2000" est la principale traduction institutionnelle dans cette direction. La Grèce a défini 262 zones comme sites "Natura 2000" qui couvrent 18,2% du territoire national, qui a été façonné au cours d'une longue histoire par des élevages ovins et caprins pâturant les végétations locales et par les pratiques correspondantes des éleveurs qui ont abouti au couvert végétal actuel. Deux zones qui accueillent un grand nombre de brebis et chèvres et devenues sites "Natura 2000" ont été choisies pour des études de gestion sur deux des situations les plus importantes : (i) zone continentale et de montagne ; et (ii) zone insulaire. La première est une partie de l'Arcadie, au centre du Péloponnèse, où existent trois sites "Natura 2000" (GR2330002, GR2520001 et GR2530004). La seconde zone d'étude est située sur deux des îles orientales de la mer Egée : Ikaria et Fourni, où ont été définies trois zones "Natura 2000" (GR4120004, GR4120005 et GR4120006). Afin de proposer des règles de bonne gestion des pâturages pour ces zones, les systèmes de production ont été étudiés, par une combinaison de données des Statistiques nationales, de CORINE et d'études de terrain, afin d'évaluer la dépendance des systèmes de ressources pâturables. Des indices de capacité de charge ont pu être ainsi déterminés et proposés aux autorités locales, accompagnés de lignes directrices pour leur gestion dans le but de préserver ces zones par un pâturage modéré.*

Mots-clés*. Systèmes de production – Gestion des pâturages – Zone naturelle protégée – "Natura 2000" – Grèce.*

I – Introduction

The multifaceted protection of extensive land areas has been recently introduced in European political priorities (Burtscher, 2004) and this reflects the growing interest of European citizens in preserving the characteristics of their homeland in a rapidly evolving world. The Bern convention on the conservation of European wildlife and natural habitats and the Directive 92/43 of the European Union Council, commonly referred to as the Habitat Directive, are the basic policy tools aiming to the preservation of biodiversity, through the conservation of natural habitats and the indigenous fauna and flora, within the territory of the European Union Member States. The latter provides the tools for the development of a network of Special Areas of Conservation (SAC), called "Natura 2000", which aims at ensuring a protection status for the natural habitats and species of Community interest. This network is expected to help the protection of rare and endangered species and their habitats by ensuring their restoration or maintenance at a favourable conservation status. The diversity of Greek biotopes reflects onto species diversity of fauna and flora, of which a relatively large number are endemic or rare. In this framework Greece has declared 262 areas designated as "Natura 2000" sites covering 18.2% of the total land area. These sites must be properly managed, either by promoting or by prohibiting certain activities, as to conserve the locally identified species of Community interest.

Natural pastures managed under extensive conditions have traditionally played an important role in the evolution of livestock production systems in Europe, particularly in the Mediterranean areas (Hadjigeorgiou *et al.*, 2005a), where they still function mainly towards the production of a range of quality products (Boyazoglu and Morand-Fehr, 2001). Since the extensive systems primarily depend on pastoral resources, the grazing livestock exert a significant impact on the vegetation (Perevolotsky and Etienne, 1999; Kramer *et al.*, 2003), not only in quantitative and qualitative terms, but also upon vegetation dynamics (Rook and Tallowin, 2003), species and community diversity (Collins *et al.*, 1998; Sternberg *et al.*, 2000; Hadjigeorgiou and Karalazos, 2005) as well as landscape (Hartnett *et al.*, 1996; Adler *et al.*, 2001), where the heterogeneous vegetation creates a particularly rich mosaic (Balent and Gibon, 1996; Perevolotsky, 2005). Overall, grazing activity is now accepted of significantly contributing to the creation and preservation of all dimensions of biodiversity (Clergue *et al.*, 2005). Sheep and goat farming is the main pastoral activity practiced in Greece since ancient times (Zygoyiannis, 2006) and a short chronological description of this is presented elsewhere (Gidarakou and Apostolopoulos, 1995; Hatziminaoglou and Boyazoglu, 2004). However, although this activity has played in the past a very important role in sustaining local population, it survives today mainly as part of the national identity despite of not being a competitive production system anymore.

As it happens in many other Mediterranean countries, the mountainous and disadvantaged areas in Greece have recently suffered a strong decline in farming activity, mainly as a result of modern development forces, with the consequent abandonment of pastoral areas (Zervas, 1998; Rancourt *et al.*, 2006). This situation led to changes in vegetation dynamics (mainly invasion of ligneous vegetation) and, therefore, in landscape structure and composition (Ispikoudis and Chouvardas, 2005). Concurrently, there is an increasing risk of environmental hazards, the most important one being uncontrolled forest fire outbreaks, followed by loss of biodiversity. Moreover, since unplanned expansion of human settlements occurs in previously rural areas, there is a dramatic increase in the risk of loss of both human lifes and properties due to the fires (Keeley, 2002).

Multifunctionality of grazing systems is widely recognized today, where along with production and economic objectives, cultural, social and environmental dimensions cannot be neglected (Steinfeld, 2006). In this sense, pastoral livestock systems can be considered as cost-effective instruments to modulate the strong inclination of vegetation development towards shrub invasion (Hadar *et al*., 1999; Sternberg *et al*., 2000; Casasús *et al*., 2005) and the accumulation of plant biomass. If adequately implemented, grazing management can be a suitable tool to maintain traditional complex landscapes and sustain biodiversity (Kramer *et al.*, 2003; Rook *et al.*, 2004). Nevertheless, on using this tool, there are important issues remaining unsolved such

as: type of pastures and constraints of use; vegetation change associated with grazing management; type of animal and stocking rate to manage pastoral resources; or quantitative advantages that can be expected from using these areas, both in terms of animal performance and environmental benefits (Bartolomé *et al.*, 2000; Rook *et al.*, 2004).

A systemic way of thinking is necessary to reach a holistic understanding of the phenomena, which determine sustainability of livestock grazing systems (Maxwell and Milne, 1995; Gibon *et al.*, 1999). A wide variety of disciplines are involved in this approach such as: technical issues concerning the management of animals and grazing resources, animal-pasture interactions and vegetation dynamics, as well as social, economic and political considerations. Hence, multidisciplinary approaches combining spatial, temporal and bio-technical skills (Flamant *et al.*, 1999) are required when addressing these issues.

The objective of this field study was to depict the systems of pastoral livestock farming in two different areas (one inland and mountainous and the other island), which are protected under the "Natura 2000" scheme and define management rules. The livestock farming systems located in the study areas were investigated at the farm scale, and farms were classified according to their structure and management, with special focus on the utilization of grazing areas, but also considering socio-economic factors. At the regional scale, existing data (CORINE land cover, on farm statistics and animal census, etc.) were combined with vegetation sampling to determine the areas available for grazing and their potential. The above data were co-investigated in order to facilitate management decisions.

II – Characterization of the study areas and their livestock farming systems

The first study area (Arcadia) lies in the center of the Peloponnese peninsula, in the south of the Greek mainland (37^{o} N, 22' E), covering some 200,000 ha. The second (Ikaria and Fourni) is part of the Eastern Aegean Islands (37^{o} N, 26' E) covering some 30,000 ha of land. Both areas have been associated with pastoral activities since antiquity, show a prominent mountainous character with a great variety of ground relief and they are hosting three "Natura 2000" sites each, of a total surface area 41,200 ha in Peloponnese (GR2330002, GR2520001 and GR2530004) and 14,300 ha in Ikaria and Fourni (GR4120004, GR4120005 and GR4120006).

The "Natura 2000" sites of Peloponnese are hosting 3 mammal species, 6 reptiles and 1 invertebrate declared "endangered" and put under protection status, through E.U. Directives 79/409 and 92/43, while those of "Ikaria and Fourni" are hosting 2 plant species, 2 amphibians, 6 mammals and 5 reptiles declared under the same status. Moreover, these sites are hosting a wealth of endemic and rare species.

The areas of study were defined on a Municipality territory level since most of the available census data are available at this level. Therefore, the Peloponnese area included 12 Municipalities, while the Ikaria and Fourni 4. In the Peloponnese study area some 175,500 sheep, 79,500 goats, 970 cattle and 2,340 equines were farmed (Table 1), at an average flock size of 56 sheep, 35 goats, 12.7 cattle and 1.4 equines per farm according to the National Data (NSSG, 2004). On average, annual productivity of livestock in this area is 90 kg milk and 17 kg meat per ewe; 100 kg milk and 14 kg meat per goat; 450 kg milk and 200 kg meat per cow (NSSG, 2004). However, a different situation is shaping in the Ikaria and Fourni area where some 5,450 sheep, 20,400 goats and 380 cattle are farmed (Table 1), at an average flock size of 48 sheep and goats, and 6 cattle per farm according to the National Data (NSSG, 2004). Animal productivity in this area is 30 kg milk and 14 kg meat per ewe; 20 kg milk and 13 kg meat per goat; 600 kg milk and 200 kg meat per cow and year (NSSG, 2004). Although for the Peloponnese area these figures are slightly lower than the respective National averages, this is not the case for Ikaria and Fourni where they are considerably lower.

A survey was organized with the aim of analyzing the livestock systems at the farm scale and to

understand the actual role that grazing livestock are playing in the management and conservation of pasture resources of the study areas. Since the majority of the farmed animals in the areas consist of sheep and goats, the survey was focused in them. Subsequently, an appropriate structured questionnaire was completed by each animal farmer interested in collaborating, always with the assistance of an expert. The survey principally recorded basic farm data i.e. number of animals per category, production output, available grazing areas, available arable areas, as well as fencing, housing and machinery infrastructure. Moreover, the survey included questions designed to collect information on farm management practices, feeding programmes for the different classes of animals, rations used, rangeland management (calendars, animal types, areas and location), stock hygiene, preventive treatments, farm economics (values of inputs and outputs), commercialization of products, social characteristics of farmers and to identify production obstacles at the individual farm level. The purpose of the study was explained clearly to farmers in order to provide information as reliable as possible.

Table 1. Herbivore livestock census and Total Livestock Units (LU) per municipality in the study areas

Municipality	Sheep	Goats	Cattle	Equines	Total LU
Peloponnese area					
Dimitsana	3,688	2,845	11	54	1,032
Falanthos	2,106	1,328	0	48	554
Foloi	40,530	7,315	0	289	7,408
Irea	5,970	1,746	0	157	1,283
Klitoros	7,633	6,587	10	295	2,377
Kontovazena	10,208	5,380	0	303	2,581
Lagadia	2,116	4,415	0	67	1,033
Lampia	8,565	8,345	38	217	2,741
Lasiona	48,026	16,950	384	222	10,231
Levidi	17,947	11,522	482	173	4,944
Tropea	19,779	7,840	39	405	4,498
Vitina	8,852	5,297	3	119	2,220
Total	*170,420*	*79,570*	*967*	*2,349*	*40,901*
Ikaria & Fourni area					
Ag. Kirikos	1,866	4,653	106	0	1,063
Evdilos	1,990	5,380	235	0	1,294
Raches	975	8,225	40	0	1,412
Fourni	610	2,165	0	0	416
Total	*5,441*	*20,423*	*381*	*0*	*4,184*

The findings of the survey are summarized in Table 2, where the large differences between the farming systems practiced in the two study areas are clearly depicted. Moreover, farm economics were evaluated by utilizing data on farm productivity, prices of inputs and outputs, subsidies etc. The Peloponnese system appears substantially more productive, in terms of milk and meat produced, compared to the Ikaria & Fourni system. However, this difference in productivity is not linearly associated with economic returns at the farms of the two areas.

Raw data, obtained through the questionnaires, were used to calculate basic nutritional requirements of the farmed animals (energy in MJ of Net Energy for Lactation and protein in kg) according to NRC (1985) and the coverage through supplement feed, whereas grazing energy and protein was calculated by difference between these measures. Table 3 summarizes the findings over the nutritional management of the investigated farms. It is clear that there were vast differences in the nutritional requirements of the average flock between the two areas, but

this is in accordance to the differences in flock size and productivity observed. Furthermore, there were differences in the proportion of supplement roughages used, since this commodity is not common on an island and farmers rely more on concentrate feeds. However, it appears that in both cases grazing material contributes more than half of the energetic requirements of these animals and about one third of their protein requirements.

Table 2. Basic production parameters of the sheep and goat farms investigated in Peloponnese (n=26) and Ikaria & Fourni (n=35) study areas and estimates of the gross farmer's income (in Euros) per reproductive female animal

	Ewes	Goats	Lambs per ewe	Kids per goat	Milk per ewe (l)	Milk per goat (l)	Gross income
Peloponnese	154	298	1.09	1.39	118	101	59
Ikaria & Fourni	25	168	0.89	0.82	36	29	32

Table 3. Nutritional requirements (calculated in MJ NEL and kg protein per year) per sheep and goat farm and the respective fractions covered through supplemented roughage and concentrates as well as grazing

	Nutritional Requirements		Supplemented				Through Grazing	
	Energy (MJ NEL/year)	Protein (kg/year)	Roughage Energy %	Roughage Protein %	Concentrate Energy %	Concentrate Protein %	Energy %	Protein %
Peloponnese	701,217	10,443	14.2	25.1	24.3	34.6	52.6	36.4
Ikaria & Fourni	377, 801	5,218	2.7	6.1	32.7	53.0	56.2	35.8

Farms in the study areas can be considered in general as being extensive. In most of the cases livestock grazed nearly all the year round, but grazing time was a fraction of the day and the flocks were shepherded. Grazing periods were also very diverse according to climatic conditions, resources availability and management choices. However, a concentration of grazing activities was noted, mainly in areas close to the animal housing facilities and a continuation of this trend can be anticipated, for reasons of convenience. Farmers for example pointed out some factors contributing to this phenomenon: lack of water in the summer, lack of road connections to the more remote grazing areas and degradation of grazing-land vegetation (shrub invasion).

Farmers' pluriactivity was common, since less than half of them could be considered as full-time farmers. It can be argued that, at present, the structure and profitability of farms were not limiting the development of agriculture and livestock activities. However, it must be mentioned that in both of the study areas the majority of the farms did not have obvious successors, so continuity of many farms in the medium-to-long term could be seriously jeopardized (Hadjigeorgiou *et al*., 2002; Bernués *et al*., 2004).

III – Characterization of grazing resources and their capacity

The boundaries of the study area were described on the map at the individual Municipalities level. Remote sensing data (CORINE land cover) were used to describe the types of land cover in the study areas and define the size of the areas available for grazing. According to these data the Peloponnese site extended over 183,710 ha and contained over 20 different land cover classes (Table 4), while the Ikaria and Fourni area amounted to 30,145 ha divided in 9 land cover classes (Table 5).

Table 4. CORINE land cover types of the Peloponnese study area, the surface they account for and their share on the total area

CORINE code	Land cover types	Area (ha)	Proportion (%)
112	Discontinued urban fabric	432.0	0.24
211	Non irrigated arable land	5,197.5	2.83
212	Permanently irrigated land	2,358.5	1.28
221	Vineyards	503.8	0.27
223	Olive groves	2,097.6	1.14
231	Pastures	2,373.2	1.29
242	Complex cultivation patterns	8,339.4	4.54
243	Principally cultivated land, with areas of natural vegetation	35,446.8	19.29
311	Broad leaved forest	3,614.9	1.97
312	Coniferous forest	26,867.3	14.62
313	Mixed forest	9,831.2	5.35
321	Natural grasslands	10,829.8	5.90
323	Sclerophyllus vegetation	44,786.2	24.38
324	Transitional woodland scrub	26,980.7	14.69
332	Bare rocks	820.6	0.45
333	Sparsely vegetated areas	2,614.5	1.42
511	Water courses	221.7	0.12
512	Water bodies	394.6	0.21
	TOTAL	**183,710.2**	**100.00**

Table 5. CORINE land cover types of the Ikaria & Fourni study area, the surface they account for and their share on the total area

CORINE code	Land cover types	Area (ha)	Proportion (%)
112	Discontinued urban fabric	212.9	0.71
243	Principally cultivated land with areas of natural vegetation	3,533.1	11.72
313	Mixed forest	3,502.7	11.62
321	Natural grasslands	3,325.1	11.03
322	Moors and heathland	5,063.6	16.81
323	Sclerophyllus vegetation	9,669.7	32.07
324	Transitional woodland scrub	1,852.8	6.14
332	Bare rocks	2,069.3	6.86
333	Sparsely vegetated areas	916.3	3.04
	TOTAL	**30,145.5**	**100.00**

Based on the above categorization and assuming that areas under CORINE codes 211, 212, 221, 223, 242 and 243 correspond to arable land, areas under codes 231, 321, 322, 323 and 324 correspond to the potential grazing land and areas under codes 311, 312 and 313 include all forestry land, it was concluded that arable land in the Peloponnese area amounted 53,940 ha (29.36%), grazing land 87,500 ha (47.63%) and forestry land 41,190 ha (22.42%). Similarly the Ikaria and Fourni area amounted 3,533 ha of agricultural land (11.72%), 19,911 ha (66.05%) of rough grazing land and 3,502 ha (11.62%) of forestry land.

Several representative sampling sites were selected in the study areas according to geographical location, mode of use and representativeness of the defined land cover types in

order to study vegetation productivity. Exclusion cages were erected in autumn to study vegetation dynamics, where for herbaceous vegetation available biomass at the start of summer, species composition and chemical composition were recorded. Shrub vegetation was clipped at the same time to estimate the biomass available for grazing and chemical composition of the samples was analyzed. Finally nutritional value of the vegetation was defined according to existing equations (Van Es, 1978). Therefore, by combining the vegetation biomass available for grazing, its nutritional value and the nutritional requirements of the breeding animals in the study areas, the grazing capacity of the natural grazing lands was assessed. Grazing capacity of the Peloponnese areas was defined at 0.45 LU/ha, while that of the Ikaria and Fourni at 0.20 LU/ha. These figures have been compared to the calculated grazing load of the areas and found quite similar, but an appreciable deviation from the mean was observed among the different municipalities of each area, indicating the uneven distribution of the animals within the areas.

IV – Discussion

Land management is already a complex discipline and becomes more difficult when specific goals, such as the conservation of biodiversity, are set. Further challenges are set when social and financial resources are limited. The designation of "Natura 2000" sites with aims of particular fauna and flora species rescuing and biodiversity conservation on a sustainable basis presents such challenges. It is well documented that efficient vegetation management is obtained through the use of grazing animals (Hadar *et al.*, 1999). However, since sustainability is not static, its conformation depends on the present and future needs of society (Milne, 2005), which in fact are constantly changing (for example, financial demands, environmental and recreation demands, product quality demands and ethical concerns). Maxwell and Milne (1995) argued that the achievement of sustainable development in pastoral systems depends on achieving intra- and intergenerational equity, environmental integrity and economic efficiency.

To guarantee intergenerational equity of resources, the concept of "reproducibility" becomes central (Thomson and Nardone, 1999). These authors identified various components of any agricultural system that need to be reproduced if sustainable development is to be achieved: soil fertility, water reservoirs, wildlife coexistence, landscape integrity, human population and economic activity. Elements that constitute and interact towards the complex relationship of pastoral systems on rangelands (Snyman, 1998) at some time point reach equilibrium and may remain as such for extense periods of time. However, since changes in the "reproducibility" of a single element can appear, then balance distortions appear and the sustainability of the whole system can be threatened. From the results of this study, it is evident that several elements of the once prevalent situation of equilibrium between livestock farming systems and pastoral resources in the study areas are currently in a transitional mode that could damage their capacity to be reproduced.

1. Despite the extensification measures of the reformed European Common Agricultural Policy (CAP), a process of livestock farming intensification has occurred in most of the sheep and goat farms in both areas of study as it was in the whole country (Zervas, 1998; Hadjigeorgiou *et al.*, 2002). The intensification of the management system, concerning nutrient inputs, is reflected to higher consumption of external inputs (feedstuffs), reduction or abolishment of utilizing grazing resources or reduction of the grazing period. Regarding other inputs, intensification is reflected on upgrading the breeding stock towards higher productivity, introducing novel technology in housing and machinery used etc. Furthermore, the limited availability of labour force and the high opportunity value of family labour are hampering the pastoral activities, as it the case with the unavailability of experienced shepherds. As a consequence of these facts, monthly and annual stocking rates as well as grazing pressure on the local vegetation are considerably lowered.

2. The process of degradation of grazing resources in European Mediterranean areas has been widely described (Balent and Gibon, 1996; Zervas, 1998; Flamant *et al.*, 1999; Bartolomé *et al.*, 2000) and this is followed by a strong tendency towards shrub and forest invasion in many mountain areas (Ispicoudis and Chouvardas, 2005). The implications for the landscape and the associated increased risk of fire hazards have been already mentioned. Although proper stocking densities can control shrub vegetation (Valderrabano and Torrano, 2000; Casasús *et al.*, 2005), doubts on the capacity of domestic animals to efficiently control the dynamics of ligneous plants are expressed (Bellon and Roggero, 1997; Bartolomé *et al.*, 2000). In any case, differences between animal species in their capacity to utilize the range of pastoral resources (Gordon, 2003) need to be taken into account.

3. There is a process of concentration of grazing areas in the easier-to-work parts of the land and where drinking water is available (Hadjigeorgiou *et al.*, 2005). This process is partly due to the reduction in the number of farmers and the subsequent higher land area available for the remaining farms. The discontinuous grazing pressure between the areas will certainly cause different patterns of change in vegetation and landscapes as well as different risk levels of environmental hazards.

4. Livestock farms in the study areas are small sized with a low level of adoption of technical advances; therefore there is always room for improving farm economic efficiency and increasing farmer's profit. However, since most of the sheep and goat farmers are aged and with little formal education qualifications, their adoption of different farming practices or new farming technologies has certain demands (Volanis *et al.*, 2007).

5. Continuity of the farms operation is threatened due to the lack of successors and a comparatively high cost for labour (competition with other economic activities, i.e. tourism). Some farmers, particularly younger ones, reject sheep and goat farming because of the harsh working conditions (Caballero, 1999) and the low social status associated with that. Moreover, despite the synergy between livestock and tourism activities (the latter is often claimed as an opportunity for rural development), in many cases the two activities are competing for labour and other local resources thus leading to tourism sector eventually reducing or substituting agricultural activities (Teruel *et al.*, 1995; Manrique *et al.*, 1999).

Finally, it should be stressed that conservation of biodiversity requires not only discipline in set grazing pressure on a year basis, but also respect of a detailed grazing calendar which might pose severe challenges to the conventional farm animals management with the respective economic implications.

1. Management implications

The sustainable development of rangelands needs to take into account local or regional conditions, rather than applying general models or recommendations (Flamant *et al.*, 1999). For our case we can summarize some relevant conditions as follows:

(i) The continuity of farming activity in the study areas does not seem to be threatened by farm structural or economic restrictions. However, social factors, related to absence of successors, social devaluation of the pastoral profession and high opportunity cost of labour, will certainly limit farming activities in the future.

(ii) Indigenous animals of moderate requirements are capable of performing adequately under these conditions (Bertaglia *et al.*, 2007) thus making pastoral systems technically viable.

(iii) The decline in livestock grazing at current management and stocking rates does not inhibit the strong vegetation dynamic towards shrub invasion. This is more intense in non-grazed areas.

(iv) Increasing pressure on pastoral resources does not appear feasible through increase in the number of farmers or the herd size, especially after the measure of decoupling from

production was approved by the revised CAP. This new policy will probably mean a further decrease in the usage of grazing lands (Roeder, 2007).

It was often claimed that the former system of CAP subsidies in the animal sector (i.e. on a headage basis) was hampering production optimization (Caballero, 2002). However, current support schemes (extensification, agro-environmental premiums) are implemented at a very low level and regardless of the farming practices at the farm. They have had, therefore, very limited effect in counteracting the intensification process observed in many farms or in promoting the utilization of larger pastoral areas or the longer grazing periods. The current trend of "Organic farming" may offer a viable solution to the continuity of these farms (Nardone *et al.*, 2004). Pastoral farmers can easily adopt this type of livestock farming since little management changes are needed, whereas the premium of this change is considerable and there appears to be no risk to the preservation of biodiversity (Hole *et al.*, 2005).

Other options, towards increasing pressure on grazing resources, could be the utilization of additional non-commercial herbivores managed by the local administrations, and aiming at keeping a sufficient stocking rate in areas of stronger invasion by shrubs. These "civil servant herds", with no "direct economic or productive" objective, should be regarded as tools to modulate vegetation dynamics (Bailey *et al.*, 1998) and they can be called "resource-conservation livestock systems".

Finally, the high level of unpredictability inherent to rangeland ecosystems (variable physical, environmental and social conditions) (Maxwell and Milne, 1995) implies that management has to be responsive, adaptive and flexible to take account of the dynamics and relationships between elements. Moreover, due to the diverse interests of different stakeholders (farmers, representatives of other economic sectors, conservationists, etc.), a process of multilateral negotiation and cooperation is strongly advisable when designing and implementing any agro-environmental or conservation policy.

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References

Adler P., Raff D. and Lauenroth W., 2001. The effect of grazing on the spatial heterogeneity of vegetation. In: *Oecologia,* 128, p. 465-479.

Bailey D.W., Dumont B. and WallisDeVries M.F., 1998. Utilization of heterogeneous grasslands by domestic herbivores: Theory to management. In: *Animal Res.*, 47(5-6), p. 321-333.

Balent G. and Gibon A., 1996. Organisation collective et individuelle dans la gestion des ressources pastorales : Conséquences sur la durabilité agroécologique des ressources. In: The Optimal Exploitation of Marginal Mediterranean Areas by Extensive Ruminant Production Systems, G. Zervas and J. Boyazoglu, (eds), *EAAP Publication,* vol. 83, p. 365-375.

Bartolomé J., Franch J., Plaixats J. and Seligman N.G., 2000. Grazing alone is not enough to maintain landscape diversity in the Montseny Biosphere Reserve. In: *Agric. Ecosyst. Environ.*, 77, p. 267-273.

Bellon S. and Roggero P.P., 1997. Elements for sustainable feeding systems in the Mediterranean region. In: *Livestock Farming Systems: More than Food Production*, J.T. Sørensen, (ed.), *EAAP Publication*, 89, p. 80-86.

Bernués A., Olaizola A., Casasús I., Ammar A., Flores N. and Manrique E., 2004. Livestock farming systems and conservation of Spanish Mediterranean mountain areas: the case of the 'Sierra de Guara' Natural Park. 1. Characterisation of farming systems. In: Rangeland and Pasture Rehabilitation in Mediterranean Areas, *Cahiers Options Méditerranéennes*, 62, p. 195-198.

Bertaglia M., Joost S., Roosen J. and Econogene Consortium, 2007. Identifying European marginal areas in the context of local sheep and goat breeds conservation: A geographic information system approach. In: *Agric. Systems,* 94, p. 657-670.

Boyazoglu J. and Morand-Fehr P., 2001. Mediterranean dairy sheep and goat products and their quality. A critical review. In: *Small Rumin. Res.*, 40, p. 1-11.

Burtscher W., 2004. Recent and future developments in the Common Agricultural Policy of the European Union. Proc. 20th EGF meeting. In: *Grassland Science in Europe*, 9, p. 3-4.
Caballero R., 1999. Castilla-La Mancha: A once traditional and integrated cereal-sheep farming system under change, In: *Am. J. Altern. Agric.,* 14(4), p. 188-192.
Caballero R., 2002. Policy schemes and targeted technologies in an extensive cereal-sheep farming system. In: *Agric. and Human Values*, 19, p. 63-74.
Casasús I., Bernués A., Sanz A., Riedel J. and Revilla R., 2005. Utilization of Mediterranean forest pastures by suckler cows: Animal performance and impact on vegetation dynamics. In: Animal Production and Natural Resources Utilisation in the Mediterranean Mountain Areas. A. Georgoudis, A. Rosati, C. Mosconi (Eds). *EAAP publication*, 115, p. 82-88.
Clergue B., Amiaud B., Pervanchon F., Lasserre-Joulin F. and Plantureux S., 2005. Biodiversity: Function and assessment in agricultural areas. A review. In: *Agronomie*, 25(1), p. 1-15.
Collins S., Knapp A., Briggs J. and Blair J., 1998. Modulation of diversity by grazing and mowing in native tallgrass prairie, In: *Science,* 280, p. 745-747.
Flamant J.C., Béranger C. and Gibon A., 1999. Animal production and land use sustainability. An approach from the farm diversity at territory level. In: *Livest. Prod. Sci.,* 61, p. 275-286.
Gibon A., Sibbald A.R., Flamant J.C., Lhoste P., Revilla R., Rubino R. and Sørensen J.T., 1999. Livestock farming systems research in Europe and its potential contribution for managing towards sustainability in livestock farming. In: *Livest. Prod. Sci*., 61, p. 121-137.
Gidarakou I. and Apostolopoulos C., 1995. The productive system of itinerant stockfarming in Greece. In: MEDIT, 3, p. 56-63.
Gordon I.J., 2003. Browsing and grazing ruminants: Are they different beasts? In: *For. Ecol. Manag.,* 181, p. 13-21.
Hadar L., Noy-Meir I. and Perevolotsky A., 1999. The effect of shrub clearing and grazing on the composition of a Mediterranean plant community: Functional groups versus species. In: *J. Veg. Sci.*, 10(5), p. 673-682.
Hartnett D., Hickman K. and Fisher L., 1996. Effects of bison grazing, fire, and topography on floristic diversity in tallgrass prairie. In: *J. Range Manage.,* 49, p. 413-420.
Hadjigeorgiou I., Vallerand F., Tsimpoukas K. and Zervas G., 2002. The socio-economics of sheep and goat farming in Greece and the implications for future rural development. In: *Options Méditerranéennes*, Séries B, 39, p. 83-93.
Hadjigeorgiou I., Osoro K., Fragoso de Almeida J.P. and Molle G., 2005. Southern European grazing lands: Production, environmental and landscape management aspects. In: *Livest. Prod. Sci*., 96 (1 SPEC. ISS), p. 51-59.
Hadjigeorgiou I. and Karalazos A., 2005. Land use, livestock farming and the creation of landscapes. In: Animal Production and Natural Resources Utilisation in the Mediterranean Mountain Areas*,* A. Georgoudis, A. Rosati, C. Mosconi (eds). *EAAP publication*, 115, p. 158-162.
Hatziminaoglou Y. and Boyazoglu J., 2004. The goat in ancient civilisations: From the Fertile Crescent to the Aegean Sea. In: *Small Rum. Res.*, 51(2), p. 123-129.
Hole D.G., Perkins A.J., Wilson J.D., Alexander I.H., Grice P.V. and Evans A.D., 2005. Does organic farming benefit biodiversity? In: *Biol. Conserv.*, 122(1), p. 113-130.
Ispikoudis I. and Chouvardas D., 2005. Livestock, land use and landscape. In: *Animal Production and* Natural Resources Utilisation in the Mediterranean Mountain Areas*,* A. Georgoudis, A. Rosati, C. Mosconi (Eds). *EAAP publication*, 115, p. 151-157.
Keeley J.E., 2002. Fire management of California shrubland landscapes. In: *Envir. Management*., 29, p. 395-408.
Kramer K., Groen T.A. and van Wieren S.E., 2003. The interacting effects of ungulates and fire on forest dynamics: An analysis using the model FORSPACE. In: *For. Ecol. Manag.*, 181, p. 205-222.
Manrique E., Olaizola A., Bernués A., Maza M.T. and Sáez A., 1999. Economic diversity of farming systems and possibilities for structural adjustment in mountain livestock farms. In: *Options Méditerranéennes,* Series B, 27, p. 81-94.
Maxwell T.J. and Milne J.A., 1995. Role of herbivores in sustainable land production systems. Principles and practice - some of the issues. In: *Recent developments in the Nutrition of Herbivores. Proc. of the IV Int. Symp. on the Nutrition of Herbivores*, M. Journet, E. Grenet, M.-H. Farce, M. Thériez and C. Demarquilly (eds). INRA editions, p. 17-31.
Milne J.A., 2005. Societal expectations of livestock farming in relation to environmental effects in Europe. In: *Livest. Prod. Sci.*, 96 (1 SPEC. ISS.), p. 3-9.
Nardone A., Zervas G. and Ronchi B., 2004. Sustainability of small ruminant organic systems of production. In: *Livest. Prod. Sci.,* 90, p. 27-39.
NRC, 1985. *Nutritional Requirements of Sheep*. 6th Edition. National Academy Press, Washington, DC.
NSSG (National Statistics Service of Greece), 2004. *Annual Agricultural Census of Greece – 2003*.

Perevolotsky A. and Etienne M., 1999. La gestion raisonnée des parcours du Bassin Méditerranéen: Un défi pour le XXI° siècle. In: *Options Méditerranéennes,* Series B, 39, p. 129-136.
Perevolotsky A., 2005. Integrating landscape ecology in the conservation of Mediterranean ecosystems: The Israeli experience. In: *Israel J. Plant Sci.*, 53(3-4), p. 203-213.
Rancourt M. de, Fois N., Lavin M.P., Tchakerian E. and Vallerand F., 2006. Mediterranean sheep and goats production: An uncertain future. In: *Small Rum. Res.*, 62(3), p. 167-179.
Roeder N., Hennessy T. and Stilmant D., 2007. Impact of the CAP-reform of 2003 on the use of pastoral land in Europe. In: Permanent and Temporary Grassland - Plant, Environment and Economy, A. De Vliegher and A. Carlier (eds.), *Grassland Science in Europe*, 12, p. 445-462.
Rook A.J. and Tallowin J.R.B., 2003. Grazing and pasture management for biodiversity benefit, In: *Anim. Res.,* 52, p. 181-189.
Rook A.J., Dumont B., Isselstein J., Osoro K., WallisDeVries M.F., Parente G. and Mills J., 2004. Matching type of livestock to desired biodiversity outcomes in pastures – A review. In: *Biol. Conservation*, 119, p. 137-150.
Snyman H.A., 1998. Dynamics and sustainable utilization of rangeland ecosystems in arid and semi-arid climates of southern Africa. In: *J. Arid Envir.*, 39(4), p. 645-666.
Steinfeld H., Gerber P., Wassenaar T., Castel V., Rosales M. and de Haan C., 2006. *Livestock's long shadow – Environmental issues and options*. FAO publication ISBN 978-92-5-105571-7, p. 390. (www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.pdf).
Sternberg M., Gutman M., Perevolotsky A., Ungar E.D. and Kigel J., 2000. Vegetation response to grazing management in a Mediterranean herbaceous community: a functional group approach. In: *J. Appl. Ecol.,* 37, p. 224-237.
Teruel A., Bernués A. and Caudevilla A., 1995. The evolution of the tourism and livestock sectors in the Pyrenean Region of Jacetania. In: *EAAP Publication,* 74, p. 265-269.
Thomson P.B. and Nardone A., 1999. Sustainable livestock production: Methodological and ethical challenges. In: *Livest. Prod. Sci.,* 61, p. 111-119.
Valderrabano J. and Torrano L., 2000. The potential for using goats to control *Genista scorpius* shrubs in European black pine stands. In: *For. Ecol. Manag.,* 126, p. 377-383.
Van Es A.J.H., 1978. Feed evaluation for ruminant. In: *Livest. Prod. Sci.*, 5, p. 331-345.
Volanis M., Stefanakis A., Hadjigeorgiou I. and Zoiopoulos P., 2007. Supporting the extensive dairy sheep smallholders of the semi-arid region of Crete through technical intervention. In: *Trop. Anim. Health and Prod.*, 39(5), p. 325-334.
Zervas G., 1998. Quantifying and optimizing grazing regimes in Greek mountain systems. In: *J. Appl. Ecol.*, 35, p. 983-986.
Zygoyiannis D., 2006. Sheep production in the world and in Greece. In: *Small Rum. Res.*, 62(1-2), p. 143-147.