

PLANT SPECIES AND ECONOMIC DIVERSITY IN SOME GRASSLANDS FROM THE SOUTH-WEST OF THE FĂGĂRAȘ MASSIF

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Abstract. The Făgăraș Massif comprises several mountains that have belonged for centuries to the people of the area (locals' communities), private properties passed on from one generation to the next. The use of natural and semi-natural grasslands is part of the rural economy and the sustainable development of each area. The grasslands from the southern slope of the Făgăraș Massif have a large area and are distributed from the alpine to the subalpine and mountainous level. The present paper presents the result of the evaluation of the diversity of plant species in the grasslands on the territory of six mountains in the South-West Făgăraș Massif. The result of the evaluation leads to the conclusion that many species have economic values for people, most of them can be used as fodder, medicinal plants, etc., and the increase of population density and distribution might determine economic loss. Good management practices applied on the plant species, but mainly regarding the causes that provoke the economic loss, can keep in balance the plant species diversity for usage by the people.

Keywords: grassland, Făgăraș Massif, plant species, good management practices.

Rezumat. Diversitatea specifică și economică a plantelor din unele pajiști din Sud-Vestul Masivului Făgăraș. Masivul Făgăraș este alcătuit din câțiva munți care aparțin de secole populației locale (obștile de moșneni), proprietăți private lăsate moștenire de la o generație la alta. Utilizarea pajiștilor naturale și semi-naturale este componentă a economiei locale și a dezvoltării sustenabile a fiecărei regiuni rurale. Pajiștile de pe versantul sudic al Masivului Făgăraș au areale largi și sunt distribuite din nivelele alpin și subalpin până în montan. Lucrarea de față prezintă rezultatele evaluării diversității speciilor de plante din pajiștile distribuite pe teritoriul a șase munți din sud-vestul masivului Făgăraș. Aceste rezultate duc către concluzia că multe specii au valoare economică pentru oameni, putând fi folosite ca hrană pentru animale, plante medicinale, etc.; creșterea densității populațiilor altor specii și a distribuției lor pot determina pierderi economice. Analiza datelor reprezintă o contribuție succintă la înțelegerea pajiștilor ca ecosistem multifuncțional. Sau vorbim despre importanța economică a speciei fără a le oferi o valoare specifică sau despre serviciile ecosistemice, înțelegerea noastră ar trebui să crească de la nivelul speciilor la nivelul ecosistemului, la nivelul serviciilor ecosistemice furnizate de pajiști.

Cuvinte cheie: pajiște, Masivul Făgăraș, specii de plante, practici bune de management.

INTRODUCTION

In the European Union, 34% of the agricultural area is represented by permanent grasslands that are important ecosystems performing essential services for human beings. In recent years, due to land use changes, permanent grassland area has decreased, and management intensity increased, resulting in a decrease in the grassland multifunctionality (SCHILS et al., 2022). Thus, there is a need to know more about the general performance of ecosystems regarding their processes, functions, and services. In agroecosystems it is already known that humans benefit from nutrient provision and biomass production generated by plant species diversity that also promotes many relevant key ecosystem functions. An increase in the plant species number and diversity is beneficial for many other functions enhancing overall multifunctionality because 'redundant' species for one ecosystemic function under given environmental conditions can play a specific important role for another function or the same function but under different environmental conditions. Species also interact with each other and can affect multiple functions, which can modify the degree of multifunctionality (SUTER et al., 2021). The definition of multifunctionality is complex, but grassland can be seen as a multifunctional system with different utilities: prevention of soil erosion and maintaining soil quality, maintenance of groundwater quality and water storage (these two utilities are intrinsically linked with productivity), plant and animal biodiversity, fodder production, ensuring landscape quality, storage of carbon, supplying soil with biologically fixed nitrogen, etc. (BERNUÉS et al., 2015; DRAGOMIR, 2017).

Over time, natural resources have influenced and shaped the socio-economic and cultural development of human communities. Natural and/or seminatural grasslands have been used by human beings as renewable resources and are important part of the natural heritage (JONES, 1996).

In Romania, traditional people used to own grasslands together in communities (associations) and use them in a sustainable manner according to customs and traditions transmitted from generation to generation. The private land was nationalised and managed by the state during the communist period and many research projects on this topic have been performed (PUȘCARU-SOROCEANU et al., 1963; ANGHIEL et al., 1967; BOȘCAIU, 1971; KOVÁCS, 1979; BĂRBULESCU & MOTCA, 1983; ȚUCRA et al., 1987). After the communist regime disappeared (1989), the communities (associations) have been recreated followed by intensive usage of grasslands, not based on customs or knowledge, but only for fast economic gain. Some publications came to the attention of the public and scientists (APIA, 2018 a, 2018b; COLDEA et al., 2001; CRISTEA et al., 2003; MARUȘCA, 2016a, 2016b, 2019a, 2019b; MARUȘCA et al., 2010, 2012, 2014; MOISUC et al., 2010; MOTCĂ et al, 1994; PĂCURAR & ROTAR, 2014; SÂRBU et al., 2004).

The grasslands (mainly pastures) of the South-West Făgăraș Massif occupy large areas; and the relief and ecological conditions vary greatly. The microclimate (local climate) is variable, as well as the diversity of plant species and the distribution of component phytocoenosis (habitats), fodder production and quality (ONETE et al., 2021). The dominant vegetation is represented by *Nardus* grasslands, but because of overgrazing, these grasslands are nowadays too degraded and species-poor in the South-West of the Făgăraș Massif to deserve classification as a Natura 2000 priority habitat 6230* (ONETE et al., 2020). The quality of the grasslands is very poor to medium, being overgrazed, which can have irreversible effects on the quality of grazing animals (reducing the quality of livestock products). Due to overgrazing and the burning by humans of alpine scrub, plant species diversity is reduced, but the dominance of some non-forage species and the distribution and density of some toxic species has increased (NICOARĂ et al., 2020).

On pastures used for grazing sheep, the study areas are situated at 1710 m (Galbena) to 2098 m (Budislavu) altitude (ONETE et al., 2020) (Fig. 1). Comprehensive studies were conducted in these grasslands from 2020 (NICOARĂ et al., 2020; ONETE et al., 2020; 2021).

MATERIAL AND METHODS

Part of Southern Carpathians, the Făgăraș Massif comprises many mountains extending over 2300 km², having distinct geomorphologic characteristics with sharp asymmetry between the northern and southern slopes, but with gentler slopes on the southern part (***, M. P., 2016). A plant species inventory has been conducted in 6 pastures from six mountains belonging to four private communities from the south-west Făgăraș Masif (Fig. 1).

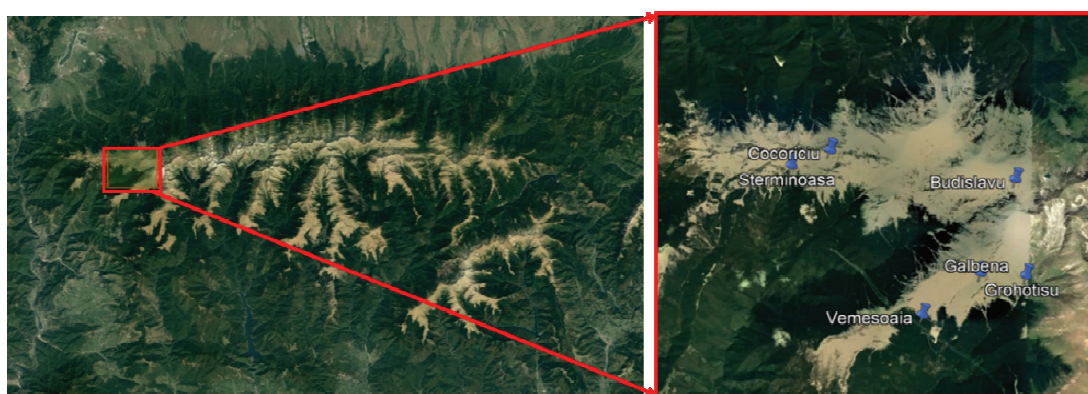


Figure 1. A general view of the Făgăraș Massif with the study area framed by red and the localisation of the grasslands in six mountains sites from the Făgăraș Massif (after NICOARĂ et al., 2020).

The private owners of four communities managing grasslands allowed the performance of the studies. In the itinerary, we recorded the abundance-dominance (in %) of plant species in every investigated site; and we established 10 x 10 m quadrats in every site based upon the homogeneity of the vegetation and the total surface of the site (Table 1).

Table 1. The name of the investigated sites and their abbreviations used later in this article.

Community name	Local Name	Number of quadrats	Abbreviation
Galbena and Vemeșoia	Galbena Mountain	3	Galb1 – Galb3
	Vemeșoia Mountain	4	Vem1 – Vem4
Sterminoasa and Budislavu	Sterminoasa Mountain	5	Ster1 – Ster5
	Budislavu Mountain	2	Bud1 – Bud2
Grohotișu	Grohotișu Mountain	4	Groh1 – Groh4
Căinenii Mici	Cocoriciu Mountain	2	Coc1 – Coc2

Pastoral Value (PV) had been calculated as an integrated index derived from floristic evaluation methods (vegetation surveys, plant species diversity investigation) (MARUȘCA et al., 2014; NICOARĂ et al., 2020). This index highlights the quality of a grassland, forage yield, and palatability of the species for livestock. This index can provide a reliable economic estimate of the grassland carrying capacity in accordance with the maximum livestock numbers in a specified grazing system (PITTARELLO et al., 2018). The values of the PV index in grasslands from the hilly regions is highly heterogenous and are not influenced by altitude, the plant species from the region do not have nutritional value (MOISUC et al., 2010).

To emphasise the economic properties of the inventoried plant species, we have used a specific literature source (KOVÁCS, 1979). The forage quality index is given by the agronomic traits of the species as follows: 5 = excellent; 4 = very good; 3 = good; 2 = medium; 1 = poor/low; 0 (X) = worthless.

Other economic qualities of the species are medicinal and aromatic (M), melliferous (MF), toxic (T), and harmful (weeds, woody species, etc.) (H). The data obtained after field inventory were statistically analysed, using the PAST program (HAMMER et al., 2001).

RESULTS

The subalpine vegetation is dominated by shrubs, except where the shrubs are clear cut, producing secondary pastures (with *Festuca supina*, *Nardus stricta*), and higher productivity (about 2-6 t/year/ha) (PUȘCARU-SOROCEANU et al., 1963; DONIȚĂ et al., 2005)

The inventory of plant species in the studied grasslands revealed that plant species diversity is low (small number of species, max. 22 species) and the pastoral value (PV) is mainly very poor to medium (Fig. 2). In these pastures, the dominant species were: *Deschampsia cespitosa* (L.) P. Beauv., *Festuca rubra* L., *Nardus stricta* L., *Poa media* Schur, *Phleum alpinum* L. ssp. *alpinum* (Nicoară et al., 2020). The micro-sites (plots) from the pastures are variable in terms of species composition, ecological conditions, and pastoral values. The pastures from Grohotișu have higher values of PV due to decreasing the impact of sheep grazing. In the areas with high intensity of grazing impact, the PV is variable toward low (Fig. 2).

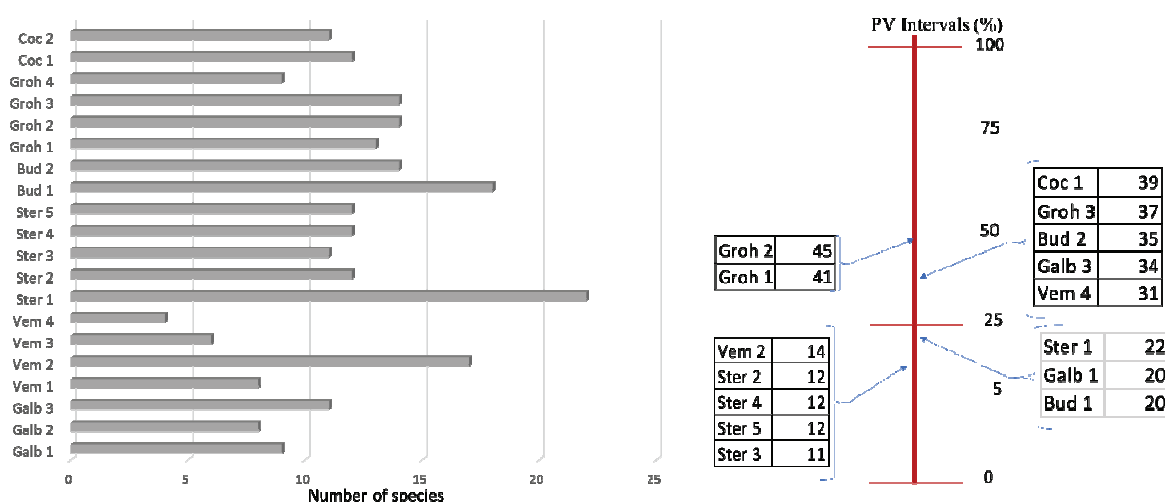


Figure 2. The number of species from grasslands (left) and their condition type (right).
 PV Intervals (%): 0-5 = Degraded; 5-15 =Very poor; 15-25 =Poor; 25-50 =Medium; 50-75 = Good; 75-100 =Very good.

PV and forage quality indexes show that the grasslands from the investigated mountains comprise plant species with no fodder quality, thus palatability (taste) is not of interest for grazing animals. When the number of fodder species is low, and the abundance of these species is reduced, the grazing livestock might also eat plant species with lower forage quality index when otherwise they would starve.

It is known that species composition and distribution vary not only with the site but also with altitude (MOISUC et al., 2010); however, palatable/forage species with high forage quality index may be found at high altitude: Poaceae Family (*Festuca rubra* L., *Agrostis capillaris* L., *Phleum alpinum* L., *Poa media* Schur), Fabaceae Family (*Trifolium repens* L.) and Apiaceae Family (*Ligusticum mutellina* (L.) Crantz). The forage quality of the investigated pastures is not good, most of the species are worthless and their percentage coverage in the investigated grasslands is variable, the smallest coverage (85-90 %) of plant species and more bare soil was from Galbena, a mountain that was overgrazed at the investigation time (Fig. 3).

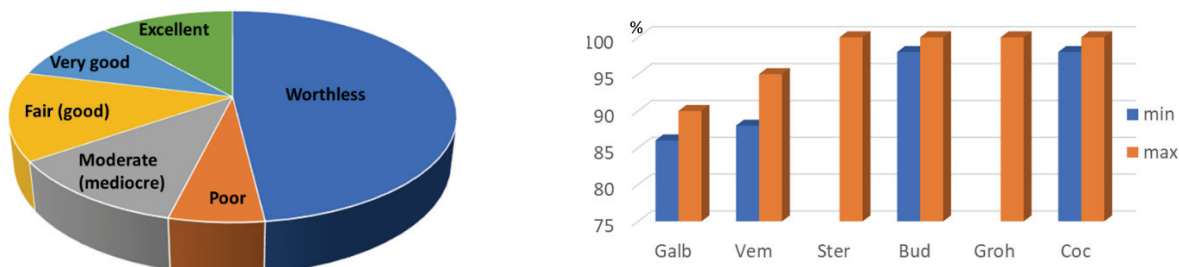


Figure 3. The forage quality of the total number of species (left) and their range of % coverage (right) in the investigated grasslands.

ONETE et al. (2020) demonstrated that the natural and anthropogenic grasslands from the alpine and subalpine zones of the mountains of the South-West Făgăraș Massif were of very poor to medium quality in terms of use as pastures for grazing with sheep. The pastures are overgrazed and, if no good management practices are applied in proper time (BLAJ et al., 2014), a vicious circle might happen, i.e. a decrease in pasture quality reduces the quality of livestock products; thus, in order to maintain their income, the local people increase the number of grazing animals thus further degrading pasture quality. The result is the uniformity of the grasslands, which increases the distribution and density of some plant species that are noxious (undesirable) and toxic for grazing animals (Fig. 4). Although some plants species are noxious and toxic for animals, human beings have found a way to use them for medicinal purposes (i.e. *Aconitum napellus*, *Veratrum album*).

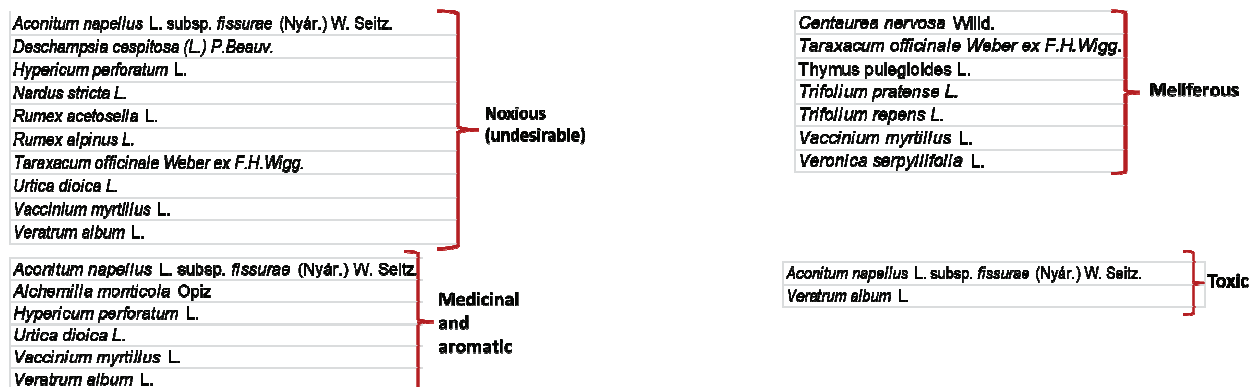


Figure 4. Economic importance of the plant species from the south-west Făgăraș Masif.

From some of the plant species, berries are gathered and sold to lowland or town people. The berries can be used for medical purposes, jam, drinks, etc. (i.e. *Vaccinium myrtillus*).

In Galbena (1710-250 m altitude) and Vemeșoia (1747-2043 m), there are many harmful plant species due to the high grazing intensity (Table 2), as these species replaced other species that could not survive after grazing. Even where disturbed, the habitats from these two mountains still contain plants species that are used by pollinators, especially bees (melliferous) and that contain active principles for human health (medicinal).

Table 2. Economic importance of some species from grazing pastures from Vemeșoia (left) and Galbena (right).

Species	M	MF	T	H
<i>Anthoxanthum odoratum</i> L.				1
<i>Festuca supina</i> Schur				1
<i>Poa media</i> Schur		1		
<i>Ligusticum mutellina</i> (L.) Crantz		1		
<i>Campanula serrata</i> (Kit. ex Schult.) Hendrych	1	1		1
<i>Crocus vernus</i> (L.) Hill ssp. <i>vernus</i>	1		1	1
<i>Veratrum album</i> L.				1
<i>Soldanella major</i> (Neilr.) Vierh.	1		1	1
<i>Potentilla ternata</i> K. Koch	1			1

Species	M	MF	T	H
<i>Deschampsia cespitosa</i> (L.) P. Beauv.				1
<i>Nardus stricta</i> L.				1
<i>Trifolium repens</i> L.		1		
<i>Vaccinium myrtillus</i> L.	1	1		1
<i>Hypericum perforatum</i> L.	1			1
<i>Veratrum album</i> L.	1		1	1

In Grohotișu, (1746-1868 m altitude), the grazing impact is not so high, and at the investigation time the grazing was stopped to allow the grassland to recover. Here, *Campanula serrata* can easily be found, which is a very important community interest species (Table 3). In Cocorâciu, the vegetation cover is 98-100% (Fig. 3) but the height of the vegetation is low and most species present are harmful (Table 3).

Table 3. The economic importance of some species from grazing pastures from Grohotișu (left) and Cocorâciu (right).

Species	M	MF	H	x
<i>Deschampsia cespitosa</i> (L.) P. Beauv.			1	
<i>Nardus stricta</i> L.			1	
<i>Trifolium repens</i> L.		1		
<i>Campanula serrata</i> (Kit. ex Schult.) Hendrych				1
<i>Vaccinium myrtillus</i> L.	1	1	1	
<i>Thymus pulegioides</i> L.		1		
<i>Veronica serpyllifolia</i> L.		1		
<i>Rumex alpinus</i> L.			1	

Species	M	MF	H
<i>Deschampsia cespitosa</i> (L.) P. Beauv.			1
<i>Nardus stricta</i> L.			1
<i>Trifolium repens</i> L.		1	
<i>Taraxacum officinale</i> Weber ex F.H. Wigg.		1	1
<i>Rumex alpinus</i> L.			1
<i>Urtica dioica</i> L.	1		1

In Sterminoasa (1740-1755 m altitude), there are many melliferous and medicinal plant species, but also harmful plant species, especially *Rumex alpinus* that replaces the original vegetation in areas where the sheepfolds were established (a similar situation exists in Grohotișu) (Tables 3 and 4).

In Budislavu (2068-2098 m altitude), due to the increased altitude, pollinators are scarce, but also the melliferous plant species are less or are completely absent, with species being adapted rather to wind pollination than to insect pollination (Table 4).

Table 4. The economic importance of some species from the grazing pastures from Sterminoasa (left) and Budislavu (right).

Species	M	MF	H
<i>Deschampsia cespitosa</i> (L.) P. Beauv.			1
<i>Nardus stricta</i> L.			1
<i>Trifolium pratense</i> L.		1	
<i>Trifolium repens</i> L.		1	
<i>Taraxacum officinale</i> Weber ex F.H.Wigg.		1	1
<i>Hypericum perforatum</i> L.	1		1
<i>Veronica chamaedrys</i> L.		1	
<i>Veronica serpyllifolia</i> L.		1	
<i>Rumex acetosella</i> L.			1
<i>Rumex alpinus</i> L.			1
<i>Alchemilla monticola</i> Opiz	1		
<i>Urtica dioica</i> L.	1		1

Species	MF	H
<i>Deschampsia cespitosa</i> (L.) P. Beauv.		1
<i>Nardus stricta</i> L.		1
<i>Trifolium repens</i> L.	1	
<i>Centaurea nervosa</i> Willd. ssp. <i>nervosa</i>	1	
<i>Veronica serpyllifolia</i> L.	1	
<i>Rumex alpinus</i> L.		1

DISCUSSIONS

This data analysis represents a brief contribution to the understanding of the grasslands as multifunctional ecosystems. We talk about the general economic importance of the species without giving them a specific value, and for ecosystem services, our understanding should rise from the species level to ecosystem level. The main ecosystem services provided by the grasslands from the south-west Făgăraș Masif are (BERNUÉS et al., 2015; LA NOTTE et al., 2017; MAES et al., 2012):

- Provisioning services: food (meat, milk, honey), raw material (fodder), water (for drinking), genetic resources (gene bank, medicinal purposes), medicinal and ornamental resources;
- Regulating services: air quality (capturing dust, chemicals), climate regulation (carbon sequestration and storage, greenhouse balance), moderation of extreme events (flood prevention), regulation of water flow (natural drainage, irrigation and drought prevention), waste treatment (water purification, nutrient retention), erosion prevention (avoidance of soil loss, vegetated buffer strips), maintenance of soil fertility (inclusive soil formation), pollination (effectiveness and diversity of wild pollinators), biological control (seed dispersal, pest and disease control);
- Habitat services: maintenance of the life cycle of migratory species (bio-corridors, stepping-stones) and of genetic diversity (especially gene pool protection);
- Cultural and amenity services: aesthetic information (harmonious agricultural landscape) opportunities for recreation and tourism (agrotourism), inspiration for culture, art, design, spiritual experience.

LIU et al. (2022) showed that the major factors influencing grassland ecosystem service values include: valuation methods, the features of the research and study site, grassland characteristics (i.e. types of grasslands) and ecosystem services. The value of the ecosystem service is high (from nearly \$4000/ha to almost \$5500/ha for different types of grasslands), and the most valuable among all ecosystem services are regulating services. The market decides the valuation of ecosystem services and most of these services remain undervalued or are ignored in decision making. The methods used to estimate ecosystem service values are also very important, thus studies to examine and apply the appropriate method(s) for more accurate ecosystem service values are required. Researchers from different disciplines may give different estimated values: social scientists often report higher values of ecosystem services than natural scientists. This demonstrates the huge ecological value potential of grassland ecosystems, which are often ignored in land-use decisions (SCHMITT et al, 2021).

CONCLUSIONS

Our intention was not to give a monetary value for the ecosystem services of the grasslands from South-West Făgăraș, but just to have an impression of the economic diversity of the plant species.

The inventory of plant species in the studied grasslands revealed that plant species diversity is low and the pastoral value is mainly very poor to medium. Plant species diversity is affected by the natural distribution of the grasslands but is strongly influenced by grazing intensity which vary with the location and altitude. The studied pastures are overgrazed and, if good management practices will not be applied, the degradation will increase. Thus, many noxious (undesirable) and toxic

plant species will overtake the palatable vegetation, producing an increase in their number and distribution, leading to poor feeding value for the grazing animals and even starvation. The owners of the animals must then move their flocks into other pastures, which further increases the extent of degradation. The better management practice comes from ancient times, when the land-owners knew that the pastures should 'rest' for some years.

The medicinal and melliferous plant species are distributed in the grasslands of the South-West Făgăraș Massif in areas with a lower intensity of grazing impact and at lower altitude.

Our study might provide data for provisioning services (raw material - fodder), genetic resources - gene bank, medicinal purposes, medicinal and ornamental resources), habitat services (genetic diversity - especially gene pool protection).

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