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# PLANT DIVERSITY AND PASTORAL VALUE OF SOME GRASSLANDS FROM ALPINE AND SUBALPINE AREAS OF SOUTH-WEST FĂGĂRAȘ MASSIF (ROMANIAN CARPATHIANS)

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***Abstract***

*The Făgăraș Massif is situated in the central area of the Carpathian Mountains, aligned west to east and whose slopes mainly have north and south aspects. The habitat diversity is high, comprising grasslands from the foot of the mountains to their summits. These grasslands have been used for sheep grazing for centuries. Our study examined six private grasslands, recording the vegetation both within enclosures, which simulate ungrazed areas, and outside the enclosures in grazed areas. In each investigated grassland, an inventory of the plant species was made and the pastoral value calculated. From these observations, we can argue that the plant species diversity and pastoral value of the grasslands decreases with increased grazing intensity and higher altitude. The overgrazed grasslands are dominated by species with low palatability which might lead to starvation of the sheep and forcing the animals to consume even these species. Thus, a good management plan can lead to sustainable future usage of these grasslands.*

***Key words****: species diversity, pastoral value, grasslands, Romanian Carpathians, Făgăraș Massif.*

## INTRODUCTION

The socio-economic and cultural development of human communities has been influenced and shaped over time by the use of natural resources at local and/or regional level. People used grasslands as renewable natural resources. Permanent grassland - natural and/or semi-natural - are an important part of the natural heritage and through their use for grazing represent the cheapest source of fodder. Grassland is a multifunctional system with different utilities: fodder production, plant and animal biodiversity, prevention of soil erosion, water storage, maintaining groundwater quality, ensuring landscape quality, storage of carbon, supplying soil with biologically fixed nitrogen, etc. (Bernués et al., 2015; Dragomir, 2017).

The quality of the soil and water of any agricultural system is intrinsically linked with its productivity. Maintaining healthy perennial vegetation aids the creation, improvement and protection of soil and maintains clean water (Jones, 1996).

In Romania 783 habitat types have been defined, of which almost 60% are natural grasslands (Doniţă et al., 2005). Maruşca et al. (2012), have been identified 3700 plant species, which, based on IUCN red list categories (2012) can be framed as is follow: 74 species are extinct, 485 are critically endangered, 200 species are vulnerable, 23 species are declared nature monuments and 1253 are rare species. 70% from these species belong to the vegetation of permanent grassland (Maruşca et al., 2010). In hilly and mountainous regions, permanent grasslands occupy large areas, but the land relief is more varied, the slopes are steeper and the local climate (microclimate) variable. The soils are thinner, skeletal and less fertile, and hence dry or with moisture excess. These factors lead to a high heterogeneity of plant species, high heterogeneity and uneven distribution of component habitats (phytocoenoses). This ecological variation leads in turn to variation in fodder production and quality i.e. different value of the permanent grasslands from one region to another and even within smaller areas. Their rational use, the implementation of appropriate work on improvement, maintenance and use can only be carried out in accordance with accurate knowledge of existing vegetation, the soil-climate conditions, as well as the natural and anthropogenic environmental factors that affect

them. Improvement of grassland quality for agriculture requires appropriate technologies adapted to the land relief and soil conditions (Motcă et al., 1994).

Pastoral Value (PV) is an integrated index derived from vegetation surveys, summarising forage yield, quality of a grassland, and palatability of the species for livestock, determined by floristic evaluation methods (Maruşca et al., 2014). This index can provide a reliable estimate of the grassland carrying capacity in accordance with the maximum livestock in a specified grazing system (Pittarello et al., 2018).As it was reported by Moisuc et al. (2010), the influence of the altitude on the values of grasslands PV index in hill areas are heterogeneous due to the important presence of poor species, without nutritional value, and it is independent of altitude itself.

As it was described in the Management Plan of ROSCI0122 Făgăraş Mountain and ROSPA0098 Făgăraş Piedmont (2016), the Făgăraş Massif is situated in central Romania, extending over 2300 km² with clearly differing slopes on the northern and southern sides, the latter being more moderate. The climate of the Făgăraş Massif has special features due to the huge size and orientation of these mountains. The mountains act as a barrier, both for the cold and wet air masses coming from the Atlantic or the North seas, retaining them longer on its northern slope, and for Mediterranean or tropical masses that stop on its southern slopes (Ciulache, 2005). The result is a dynamic climate on the north side (humid, and cold) and a more moderate, calm and clear on the southern side. The elements of the climate (temperature, wind, rainfall) are influenced by altitude in the Făgăraş Massif. This is reflected in the existence of differing bioclimatic conditions favouring either deciduous forests, coniferous forests or alpine meadows. In addition, on the southern side, the forest rises to a higher altitude than on the northern, Transylvanian one (Kotek et al., 2006). Alpine grasslands (2300-2544 m altitude) are more extensive than grasslands in subalpine (1600-2300 m altitude) and submontane areas (650-1600 m altitude) where they are present in mosaics with coniferous, mixed and beech forests (Ielenicz and Pătru, 2005). In alpine areas, the grasslands are composed of short species (*Carex curvula, Juncus trifidus, Festuca supina*) and the productivity is very low (about 0.8 t/year/ha) due to a) the lower temperature during the short growing period for alpine plants and b) the shallower, acidic soils poor in nutrients. At the subalpine level, the temperature is somewhat higher and the growing season longer, but the soils are still shallow, nutrient-poor and acidic. 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) (Puşcaru-Soroceanu et al., 1963; Doniță et al., 2005).

## MATERIALS AND METHODS

The study area is situated in the South-West region of Făgăraş Mountains (Photo 1), in alpine and subalpine levels.

Photo 1. A general view of Făgăraş Massif with the study area framed by yellow

Our study was performed in four community private grasslands used as grazing pastures for sheep, spread over six mountains (Photo 2).


Photo 2. The localization of the grasslands in six mountains sites from Făgăraş Massif

In the grazing areas, the representatives of the communities have installed enclosures delimitating 10 x10 m plots (Photo 3) where grazing has been banned.

Photo 3. The image of enclosures used

The plant species were identified within and outside enclosures, and the species were recorded using the *pratological* method of Ivan and Doniță (1975) with coverage % of each species encountered and their classification in economic groups: grasses, legumes, sedges and rushes, other families, moss and lichens, woody species. This classification is recommended as a quick method for determining grassland vegetation (Blaj et al., 2014).

Where necessary, the species identification guide (Ciocârlan, 2009; Sârbu et al., 2013) was used for more precise identification of vascular plant species.

We used the formula for determination of pastoral value described by Maruşca et al. (2012) where PV is the indicator of pastoral value expressed as a percentage:

$$PV = \frac{\Sigma PC \times IC}{5}$$

PC = participation in herbaceous layer;

IC = forage quality index.

Following the methodology of Maruşca et al (2014), in the table of the inventoried species (with percentage participation of the species) we added the forage quality index (IC) and calculated the pastoral value index that allows the framing of the condition type for each grassland (Table 1).

Table 1. The grassland condition type based on calculated PV

| Grassland condition type | PV Intervals (%) |
|---|---|
| Degraded | 0-5 |
| Very poor | 5-15 |
| Poor | 15-25 |
| Medium | 25-50 |
| Good | 50-75 |
| Very good | 75-100 |

The forage quality index is given by the agronomic traits of the species as it is given in the literature (Kovacs, 1979).

In each grassland, apart from plots within the enclosures, we inventoried plots in the open grazed grassland: a) 5 plots in Sterminoasa (S1-S5) situated at 1740-1755 m altitude, with W aspect and slopes $15^0$; b) 4 plots in Budislavu (B1-B4) situated at 2073-2098 m altitude, with SW aspect and slopes $20\text{-}30^0$; c) 2 plots in Cocorîciu (C1-C2) situated at 1918-1919 m altitude, with S aspect and $15^0$ slopes; d) 4 plots in Grohotișu (Gr1-Gr4) situated at 1746-1868 m altitude, with E and S-SE aspect and $20\text{-}25^0$ slopes; e) 3 plots in Galbeana (Ga1-Ga3) situated at 1710-2054 m altitude, with W and W-SW aspect and $15^0$ slopes; f) 4 plots in Vemeșoaia (V1-V4) situated at 1747-2043 m altitude, with S and S-SE aspect and $15\text{-}20^0$ slopes.

The data obtained after field inventory, was statistically analysed, and for multivariate Detrended Canonical analysis (DCA) - characteristic species/plot, we used the PAST program (Hammer et al., 2001).

## RESULTS AND DISCUSSIONS

The inventory of plant species in the studied grasslands revealed that the species number is low (Figure 1) dominated by *Deschampsia cespitosa* (L.) P. Beauv., *Festuca rubra* L., *Nardus stricta* L., *Poa media* Schur, *Phleum alpinum* L. ssp. *alpinum*.

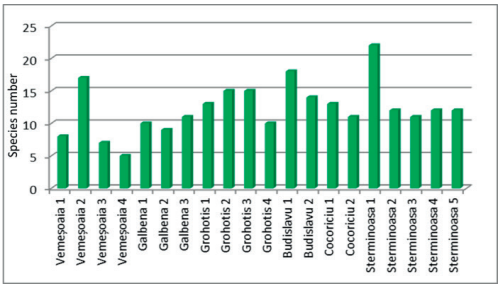


Figure 1. The number of the species inventoried in studied grasslands

In ungrazed enclosures, the species diversity is greater (V2, G3, G3, B1, C1, S1) and the percentage of those species with a high forage quality index was higher when compared to grazed areas. In grazed areas, the palatability of these species made them to be overgrazed and replaced by species without forage quality (*i.e. Deschampsia cespitosa*).

Species diversity differs in relation to the altitude and slope (Figure 2), but the impact of grazing is to produce uniform areas, becoming similar due to the dominance of some species (*Deschampsia cespitosa, Nardus stricta*).

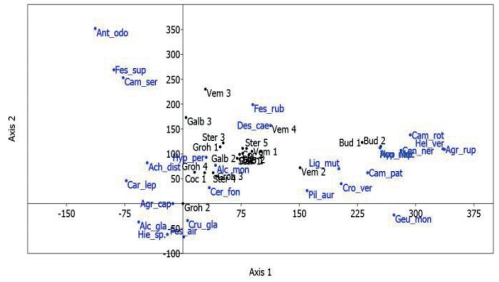


Figure 2. Detrended Canonical analysis (DCA) - characteristic species/plot

There was low variation in species composition in relation to site, but the species distribution correlated with altitude. Forage species with a forage quality index between 1 and 5 from Poaceae Family (*Festuca rubra* L. *Phleum alpinum* L. ssp. *alpinum*, *Poa media* Schur), Fabaceae Family (*Trifolium repens* L.) and Apiaceae Family (*Ligusticum mutellina* (L.) Crantz) are present at high altitude (*i.e.* B1-B4 at 2073-2098 m altitude). It is known that these forage plant species are cold tolerant (Filho et al., 2018) and thus the number of plant species preferred by grazing animals was not affected by the harsh climate at high altitudes in the Făgăraș mountain range.

Analysis of the forage quality of species recorded in this study showed that most of them are worthless, with no pastoral value for grazing animals (Figure 3).

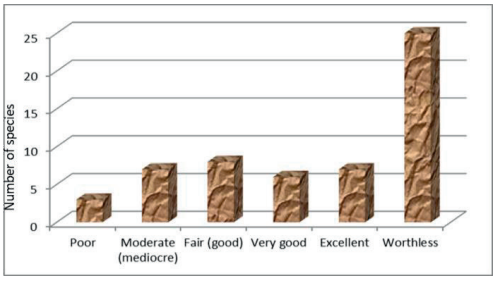


Figure 3. Forage plants species (used by grazing animals)

Our investigations on the altitudinal gradient showed that the entire South-West region of the Făgăraș Mountains is dominated by South-Eastern Carpathians grasslands with *Nardus stricta* and *Viola declinata* (Romanian Habitat RO3609). This type of grassland is degraded due to medium to high grazing impact. The impact transforms the original habitat RO3609 into an anthropogenic habitat dominated by *Deschampsia caespitosa.* Where valuable forage species do survive, the overgrazing limits their growth at the soil level thus making them not accessible to the grazing animals.

The grasslands dominated by *Nardus stricta* are well developed in the areas. Among swards of *Nardus* it is difficult for other species to arise. The ecological factors that stimulate spread of *Nardus* habitat are acidity and lack of nutrients in the soil, combined with climate, relief and grazing intensity (Pușcaru-Soroceanu et al., 1963). Maruşca et al. (2014) have classified these grasslands as the *Nardus stricta* series of sub-alpine level (of junipers) in high mountains.

This type of grassland belongs within the subalpine oligotrophic pastures of all high mountainous massifs that are characteristic of podzolic soils, acidic and poor in nutrients, occupying tens of hectares at altitudes between 1200 and 1800 m (Coldea et al., 2001). These grasslands develop well toward lower zone of the alpine level (Pușcaru-Soroceanu, 1963).

The pastoral value (Figure 4) of the studied grasslands is relatively low, in spite of the high proportion of grasses and leguminous species (Poaceae and Fabaceae).

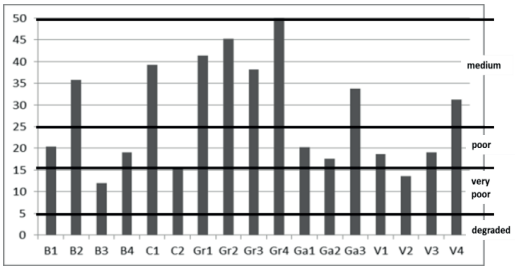


Figure 4. Pastoral Value of the grasslands of South-West Făgăraș Massif

Using the pastoral value intervals (%) of grasslands defined in Table 1, we can classify the studied grasslands as follows: a) very poor (B3 at 2098 m altitude, C2 at 1918 m altitude, V2 at 1887 m altitude); b) poor (B1 at 2090 m altitude, B4 at 2073 m altitude, Ga1 at 2054 m altitude, Ga2 at 2050 m altitude, V1 at 1747 m altitude, V3 at 2043 m altitude); c) medium (B2 at 2068 m altitude, C1 at 1919 m altitude, Gr1 at 1746 m altitude, Gr2 at 1747 m altitude, Gr3 at

1721 m altitude, Gr4 at 1868 m altitude, Ga3 at 1710 m altitude, V4 at 1933 m altitude).
Grassland type and quality are determined not by the altitude but by the grazing pressure which, under increased intensity, notably modifies the grassland type (positive feed-back).

## CONCLUSIONS

The grasslands have very poor to medium quality, due to both natural and anthropogenic impacts; they are overgrazed, which can have irreversible effects on the quality of grassland and thus on grazing animals (reducing the quality of livestock products). The main threats to the studied grasslands are the overgrazing and the burning of alpine scrub. This results in reduced plant species diversity, increased dominance of some non-forage species and increased distribution and density of some toxic species. Overgrazing and intensification will produce more uniform grasslands over a large area, regardless of climate, geology and natural soil diversity.
Local people should become aware of important new management actions, other than grazing, that support the other ecosystem services provided by grasslands. Conservation of grassland does not imply taking no action but adopting actions for sustainable use and expansion of the resources (e.g. genetic, soil quality & quantity).
Climate change mitigation for the eco-sustainability and biodiversity of production systems is the priority for the European agricultural agenda.
Minimising the damaging ecological impact of farms is a key factor for farmers seeking to obtain public incentives for enhancing the multifunctionality of agricultural systems expressed as services for society. Thus, the assessment and valuation of environmental performance may be a very important factor to improve the competitiveness of grassland-based farming, especially for those located in protected areas.

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