CONTRIBUTIONS TO THE GRASSLAND PRODUCTIVITY EVALUATION IN THE PERȘANI MOUNTAINS

Teodor MARUSCĂ[1], Pantelimon ULARU[2], Dan Marian GUREAN[2],
Marcela Mirela Mihaela DRAGOȘ[1], Elena TAULESCU[1]

[1]Research-Development Institute for Grassland - Brașov
Cucului Str., no. 5, Cod: 500128, Brașov County
E-mail: maRuscăt@yahoo.com
[2]Transilvania University of Brașov

Abstract

The Perșani Mountains, which are part of the Curvature Carpathians, separate the Transylvanian Plateau from the Bârsa Depression, border on the east, north and west with the Olt River, have a maximum height of 1292 m on Măgura Codlei and an area of approx. 1kmp. The permanent grasslands are quite well represented, starting with the hayfields from Lunca Oltului, up to the grasslands from the oak and beech floors, at higher altitudes. For grasslands harvested in hay, belonging to the phytosociological associations Arrhenaterum elatioris, Festucetum pratensis and Typhoidetum arundinaceae, a production of over 20 t / ha of green mass was evaluated and those degraded as Molinietum coerulae and Deschampsietum caespitosae only, 1 - 3 t / ha green mass with fodder value. The pastoral value of the hayfields is 4 - 20 for the degraded ones and 65 - 90 for the best managed ones. On the grasslands used for grazing with animals, the highest productivity is estimated at the associations Lolio-Potentilletum anserinae, Festucetum rubrae submontanum and Agrostetum capillaris, of 11 - 16 t / ha forage green mass and 63 - 74 pastoral value. The grasslands with the lowest productivity are from the associations Botriochloetum ischaemi and Festuco-Nardetum strictae submontanum with 1 - 3 t / ha forage green mass and 11 - 22 pastoral value. On average, on the grasslands in these mountains, in an optimal grazing season of 165 days, 0.73 livestock units (LSU/ha) can be maintained.

Keywords: permanent grasslands, green mass production, pastoral value, pastoral capacity

INTRODUCTION

Establishing the productivity of mountain grasslands (pastoral value and forage green mass production), is a very important indicator for establishing the optimal load with animals in the grazing season, and estimating hay production for the winter season (BĂRBULESCU, MOTCĂ, 1983).

Usually, forage production is established by weighing the mowed grass from fenced areas and the quality, by chemical determinations in the laboratory (PĂCURAR, ROTAR, 2014). Specifically, this method is more difficult, almost impossible to achieve on isolated grasslands or with difficult access such as mountains grasslands. For this purpose, a new method of evaluating the productivity of grasslands based on floristic survey was developed (MARUȘCA, 2019).

The results obtained so far are encouraging (MARUSCĂ ET AL., 2019A, 2019b).

After a higher number of evaluations for the same phytosociological association and alliance on mountain massifs groups in the Carpathians, it is possible to establish more accurately the grazing capacity and the yield in animal products. Likewise, these data are necessary for the elaboration of pastoral arrangements.

MATERIALS AND METHOD

For reference, we analyzed the doctoral thesis "Research on cormophytes from the Perşani Mountains", drafted by biologist Ularu Pantelimon, under the guidance of Prof. Dr. Traian I. Ștefureac, and presented in 1972 at the Faculty of Biology of the University of Bucharest.

Chapter III of the doctoral thesis describes the vegetation of the Perşani Mountains in which the following cenotaxons were outlined for the permanent grasslands:

Cl. *PHRAGMITETEA,* Tx. et. Prsg.1942
Reeds - cattails
Ord. *PHRAGMITETALIA*, W. Koch 1926
Al. *Magnocaricion elatae,* (Br.-Bl. 1925) W. Koch 1926
1. As**.** *Caricetum vulpinae,* Soó 1927
2. As. *Typhoidetum arundinaceae*, (W.Koch 1926, Libb.1932) Eggler 1933

Cl. *MOLINIO - ARRHENATHERETEA,* Tx. 1937
Riverside grassland vegetation (meso - hygrophilous)
Ord. *MOLINIETALIA*, W. Koch 1926
Al. *Molinion coerulae,* W. Koch 1926
3. As**.** *Molinietum coerulae,* (All.1922) W. Koch 1926
Al. *Agrostion albae*, Soó 33
4. As. *Deschampsietum caespitosae*, Horv. 1930
5. As. *Agrostetum stoloniferae*, Ujv. 1933
6. As. *Festucetum pratensis*, Soó 1938
Ord. *ARRHENATHERETALIA,* Pawl. 1928
Mesophilic grasslands vegetation
Al. *Arrhenatherion elatioris*, (Br.-Bl. 1925) Pawl. 1928
7. As. *Arrhenatheretum elatioris*, (Br.-Bl. 1919) Sch. 1925
Ord. *AGROSTIDETO - FESTUCETALIA RUBRAE*, Puşc. şi col. 1956
Al. Cynosurion cristati, Br.-Bl. et. Tx. 1943
8. As. *Agrostetum capillaris,* Szafer, Pawl, Kulcz 1923
9. As. *Festucetum rubrae submontanum,* (Scam. 1955) Oberd 1957
10. As. *Festuco- Nardetum strictae submontanum,* Csűrős 1960

Cl. *FESTUCO - BROMETEA,* Br-Bl et. Tx. 1943
Xerophilous grasslands vegetation
Ord. *FESTUCETALIA VALESIACAE*, Br-Bl et Tx. 1943
Al. *Festucion sulcatae* Soó 1940
11. As. *Festucetum valesiacae,* Burduja et. col. 1956
12. As. *Botriochloetum ischaemi,* Krist 1937
Cl. *PUCCINELIO - SALICORNIETEA,* Țopa 39
Salty grasslands
Ord. *PUCCINELLIETALIA*, Soó 40
Al. *Puccinellion limosae*, (Klika 1937) Wend. 1943
13. As. *Puccinellietum limosae,* Rpcs. 1927

Cl. *PLANTAGINETEA MAJORIS*, Tx. et. Prsg. 1950
Trampled lands vegetation
Ord. *PLANTAGINETALIA MAJORIS*, Tx. (1947), 1950
Al. *Polygonion avicularis,* Br-Bl 1931
14. As. *Lolio - Potentilletum anserinae*, Knapp 1946

Aquatic vegetation, fixed aquatic vegetation and ruderal vegetation were excluded from the grassland phytosociological units.

The assessment of abundance - dominance (A - D), from the grass carpet of the grasslands was made according to the Braun Blanquet appreciation scale, which was transformed into participation percentages (P%) for the calculation of productivity (Table 1).

Table 1

Participation assessment (P%) of synthetic surveys, depending on the abundance + dominance (AD) and mean constancy (K%) scales for permanent grassland phytocenoses (after MaRuscă 2019, revised)

AD scale Br. – Bl.	AD based on K (%)				
	V (81 – 100%)	IV (61 – 80%)	III (41 – 60%)	II (21 – 40%)	I (<20%)
5	**87,5***	**61,3**	**43,8**	**26,3**	**8,8**
4 - 5	75,0	52,5	37,5	22,5	7,5
3 - 5	62,5	43,8	31,3	18,8	6,3
2 - 5	52,5	36,8	26,3	15,8	5,3
1 - 5	46,3	32,4	23,2	13,9	4,6
+ - 5	44,0	30,8	22,0	13,2	4,4
4	**62,5***	**43,8**	**31,3**	**18,8**	**6,3**
3 – 4	50,0	35,0	25,0	15,0	5,0
2 – 4	40,0	28,0	20,0	12,0	4,0
1 – 4	33,8	23,7	16,9	10,1	3,4
+ - 4	31,5	22,1	15,8	9,5	3,2
3	**37,5***	**26,3**	**18,9**	**11,3**	**3,8**
2 – 3	27,5	19,3	13,8	8,3	2,8
1 – 3	21,3	14,9	10,7	6,4	2,1
+ - 3	19,0	13,3	9,5	5,7	1,9
2	**17,5***	**12,3**	**8,8**	**5,3**	**1,8**
1 – 2	11,3	7,3	5,7	3,4	1,1
+ - 2	9,0	6,3	4,5	2,7	0,9
1	**5,0***	**3,5**	**2,5**	**1,5**	**0,5**
+ - 1	2,8	2,0	1,4	0,8	0,3
+	**0,5***	**0,4**	**0,3**	**0,2**	**0,1**

*) A + D appreciation scale transformation, Braun - Blanquet, in percentages, according to Tüxen and Ellenberg, 1937, from Cristea et al., 2004.

The surveys thus prepared, with the participation in percentages, fodder quality indices (F) of the species were noted:

1 = toxic plants for animals and humans;
2 = plants harmful to animal products;
3 = weeds harmful to the meadows vegetal carpet;
4 = low fodder plants (ballast);

5 = mediocre forage plants (previously considered F1 on a 5-step scale);
6 = medium fodder plants (former category F2);
7 = good fodder plants (formerly F3);
8 = very good fodder plants (formerly F4);
9 = excellent fodder plants (formerly F5);
X = unknown value.
Pastoral value (PV) was calculated according to the formula:

PV = Σ P (%) x F$_4$ + ...+ P (%) x F$_9$ / 9

The assessment of a grassland quality after calculating the pastoral value is as follows:
0 - 5 degraded meadow (Deg.);
5 - 15 very low (VL);
15 - 25 low (L);
25 - 40 mediocre (Med.);
40 - 60 middle (Middle);
60 - 80 good (G);
80 - 100 very good (VG).

The same is done for establishing the average indices for useful phytomass (MI); (M1 = very poor .... M9 = very good) which is divided by 100, according to the formula:

MI = Σ P(%) x M$_1$ + ...+ P(%) x M$_9$ / 100

The average phytomass index (MI) calculated for the species with forage value indices F4 - F9, is further multiplied by the coefficients of transformation in usable grass (green mass) production for animals, presented in table 2 (MaRuscă 2019).

Table 2

Production indices for fodder species and estimate of useful
Yield per hectare of permanent non-fertilized meadows

Average green mass production indices (MI)	Transformation coefficients in green mass production (GM)	Estimation of forage green mass production (GM) (t/ha)	Production value assessment
0,1 – 0,5	x 1,8	0,2 – 0,9	very low
0,5 – 1,0	x 1,9	1,0 – 1,9	
1,0 – 1,5	x 2,0	2,0 – 3,0	low
1,5 – 2,0	x 2,1	3,2 – 4,2	
2,0 – 2,5	x 2,2	4,4 – 5,5	low - medium
2,5 – 3,0	x 2,3	5,8 – 6,9	
3,0 – 3,5	x 2,4	7,2 – 8,4	medium
3,5 – 4,0	x 2,5	8,8 – 10,0	
4,0 – 4,5	x 2,6	10,4 – 11,7	medium-good
4,5 – 5,0	x 2,7	12,2 – 13,5	
5,0 – 5,5	x 2,8	14,0 – 15,4	good
5,5 – 6,0	x 2,9	16,0 – 17,4	
6,0 – 6,5	x 3,0	18,0 – 19,5	good-very good
6,5 – 7,0	x 3,1	20,2 – 21,7	
7,0 – 7,5	x 3,2	22,4 – 24,0	very good
7,5 – 8,0	x 3,3	24,8 – 26,4	
8,0 – 8,5	x 3,4	27,2 – 28,9	excellent
8,5 – 9,0	x 3,5	29,8 – 31,5	

The optimum grazing capacity (GC) expressed in LSU/ha is determined by the formula:

$$GC\ (LSU/ha) = \frac{GM\ (kg/ha)}{GSD\ (zile)x\ 65}$$

in which GSD represents the grazing season duration and 65, the daily green mass required for one livestock unit (LSU).

Depending on the GP value, the grasslands productivity is classified as follows:

LSU/ha	**Grassland assessment**
0,01 - 0,20	Degraded (Degr.)
0,21 - 0,40	Very low (VL)
0,41 - 0,60	Low (L)
0,61 - 0,80	Mediocre (Med.)
0,81 - 1,20	Middle (Middle)
1,21 - 1,60	Good (B)
1,61 - 2,00	Very good (VG)
Over 2,00	Excellent (Exc.)

According to this method of evaluating the grasslands productivity based on floristic surveys, the permanent grasslands from the studied area, were characterized from an economic point of view.

RESULTS AND DISCUSSION

Before assessing the productivity of permanent grasslands, a synthesis of the natural conditions (altitude and exposure), in which the associations meet, the degree of vegetation covering, the number of surveys and the component species was made. (Table 3).

Table 3

General data on the natural conditions of praticultural Phytocenoses from the Perşani Mountains

No.	Phytocoenosis (association)	Alt. m	Exposition	Incl. (grade)	Vegetal cover %	No. of surveys	Species
1	As. *Caricetum vulpinae*	450-600	Plan	0	93	14	42
2	As. *Typhoidetum arundinaceae*	450-550	Plan	0	96	11	55
3	As. *Molinietum coerulae*	540-650	S,SE,SV,V	3-5	98	7	79
4	As. *Deschampsietum caespitosae*	460-620	Plan	0	98	15	75
5	As. *Agrostetum stoloniferae*	460-680	Plan	0	97	20	121
6	As. *Festucetum pratensis*	450-600	Plan	0	99	19	105

No.	Phytocoenosis (association)						
7	As. *Arrhenatherietum elatioris*	460-740	Plan	0	97	9	94
8	As. *Agrostetum capillaris*	580-800	S,E,V, SV, SE, N	3-10	100	20	123
9	As. *Festucetum rubrae submontanum*	620-680	S, SE, E,V,N	3-7	100	15	86
10	As. *Festuco-Nardetum strictae submontanum*	510-1020	S,E,V, SE, NE	0-15	100	15	109
11	As. *Festucetum valesiacae*	600-770	S, SE, SV, V, E, N,NE	3-30	87	16	135
12	As. *Botriochloetum ischaemi*	470-650	S,V,E,SE	15-30	95	10	102
13	As. *Puccinellietum limosae*	460-470	Plan	0	93	6	39
14	As. *Lolio - Potentilletum anserinae*	480-610	Plan	0	94	5	37
	TOTAL - AVERAGE	**450-1020**	**All**	**0-30**	**96**	**182**	**86**

The praticultural associations that are part of the alliances *Magocaricion elatae, Molinion coerulae, Agrostion albae* and *Arrhenatherion elatioris* are in most cases harvested as hay. (Table 4).

Table 4

Productivity of grasslands harvested as hayfields in Perşani Mountains

No.	Phytocoenosis (association)	Species cover (%)		Pastoral value		Green mass production		Value assessment
		Harmful	Forager	ind.	%	t/ha	%	
	Al. *Magnocaricion elatae*							
1	As. *Caricetum vulpinae*	14	79	42,1	79	11,23	83	Medium
2	As. *Typhoidetum arundinaceae*	10	86	64,1	120	23,20	166	Very good
	Al. *Molinion coerulae*							
3	As. *Molinietum coerulae*	93	5	3,5	7	0,40	3	Very low
	Al. *Agrostion albae*							
4	As. *Deschampsietum caespitosae*	73	26	19,2	36	2,98	21	Low
5	As. *Agrostetum stoloniferae*	6	91	75,2	141	16,41	118	Good
6	As. *Festucetum pratensis*	8	91	89,6	168	22,72	163	Very good
	Al. *Arrhenatherion elatioris*							
7	As. *Arrhenatherietum elatioris*	8	89	79,6	149	20,74	149	Very good
	AVERAGE	**30**	**67**	**53,3**	**100**	**13,95**	**100**	**Good**

On average, hayfields are made up of species with forage value (67%), the most degraded are the associations *Deschampsietum caespitosae* and *Molinietum coerulae* with 73-93% non-valuable species.

The most productive hayfields are part of the associations: *Arrhenatherietum elatioris* (80 PV and 21 t/ha GM), *Festucetum pratensis* (91 PV and 23 t/ha GM) and *Typhoidetum arundinaceae* (64 PV and 23 t/ha GM), followed by *Agrostetum stoloniferae* (75 PV and over 16 t/ha GM).

The praticultural associations valorized mainly by grazing with animals, are part of the phytosociological alliances *Cynosurion cristati, Festucion rupicolae, Puccinellion limosae* and *Polygonion avicularis* being with a lower productivity than hayfields. (Table 5).

Thus, the associations *Botriochloetum ischaemi* and *Festuco-Nardetum submontanum* have in their composition 70% participation of harmful species (F1-F3) that give 11-22 pastoral value and 1-3 t/ha forage green mass production that allows a load of only 0,1-0,3 LSU/ha.

The most valuable associations are *Lolio-Potentilletum anserinae* (74 PV and 16 t/ha GM), *Festucetum rubrae submontanum* (67 PV and 13 t/ha GM) and *Agrostetum capillaris* (63 PV and 11 t/ha GM).

The animals loading of the most valuable associations is 0,6-1,5 LSU/ha, in an average grazing season of 165 days.

On average, hayfields are made up of species with forage value (67%), the most degraded are the associations *Deschampsietum caespitosae* and *Molinietum coerulae* with 73-93% non-valuable species.

The most productive hayfields are part of the associations: *Arrhenatherietum elatioris* (80 PV and 21 t/ha GM), *Festucetum pratensis* (91 PV and 23 t/ha GM) and *Typhoidetum arundinaceae* (64 PV and 23 t/ha GM), followed by *Agrostetum stoloniferae* (75 PV and over 16 t/ha GM).

The praticultural associations valorized mainly by grazing with animals, are part of the phytosociological alliances *Cynosurion cristati, Festucion rupicolae, Puccinellion limosae* and *Polygonion avicularis* being with a lower productivity than hayfields. (Table 5).

Thus, the associations *Botriochloetum ischaemi* and *Festuco-Nardetum submontanum* have in their composition 70% participation of harmful species (F1-F3) that give 11-22 pastoral value and 1-3 t/ha forage green mass production that allows a load of only 0,1-0,3 LSU/ha.

The most valuable associations are *Lolio-Potentilletum anserinae* (74 PV and 16 t/ha GM), *Festucetum rubrae submontanum* (67 PV and 13 t/ha GM) and *Agrostetum capillaris* (63 PV and 11 t/ha GM).

The animals loading of the most valuable associations is 0,6-1,5 LSU/ha, in an average grazing season of 165 days.

Table 5

Grasslands productivity and optimal animal loading during
165 days optimal grazing season in Perşani Mountains

No	Phytocoenosis (association)	Species cover (%)		Pastoral value		Green mass production		Grazing season duration (days)	Animals loading LSU/ha	Value assessment
		Harmful	Forager	ind.	%	t/ha	%			
					Al. ***Cynosurion cristati***						
8	As. *Agrostetum capillaris*	14	86	63,2	139	11,15	143	160	1,07	Middle

9	As. *Festucetum rubrae submontanum*	8	92	67,4	148	13,37	171	165	1,33	Good
10	As. *Festuco-Nardetum strictae submontanum*	70	30	21,7	48	3,00	38	155	0,28	Very low
	Al. *Festucion rupicolae*									
11	As. *Festucetum valesiacae*	15	72	42,2	93	6,65	85	160	0,6478	Mediocre
12	As. *Botriochloetum ischaemi*	70	25	10,8	24	1,16	15	170	0,11	Degraded
	Al. *Puccinellion limosae*									
13	As. *Puccinellietum limosae*	40	53	40,2	88	3,40	43	180	0,29	Very low
	Al. *Polygonion avicularis*									
14	As. *Lolio - Potentilletum anserinae*	18	76	73,5	161	16,01	204	170	1,45	Good
	AVERAGE	**34**	**62**	**45,6**	**100**	**7,82**	**100**	**165**	**0,73**	**Mediocre**

By mapping the praticultural associations and determining the areas that occupy them, it will be possible to finally establish the pastoral value and the average production per hectare of a larger body of grassland with the optimal grazing capacity.

After determining a greater number of praticultural associations or phytosociological alliances (habitats) on mountain massifs, it is possible to more accurately assess the current and potential productivity of mountain grasslands in our country for the economic growth of the animals that use them.

CONCLUSIONS

The permanent grasslands in the Perșani Mountains that belong to 14 associations and 8 phytosociological alliances (habitats) have a very high biological diversity, having on average 86 species on a cenotaxon (association).

The average productivity of hayfields is quite high, respectively 53 pastoral value and 14 t/ha forage green mass.

The pastures have on average 46 pastoral value and 8 t/ha forage green mass with an optimal load of 0.7 LSU/ha, during a grazing season.

The data regarding the productivity of the permanent grasslands evaluated on the basis of a floristic survey, serve, first of all, for the elaboration of the pastoral arrangements.

REFERENCES

1. BĂRBULESCU, C., MOTCĂ, GH., 1983. Pășunile munților înalți, *Editura "Ceres"*, București.
2. CIOCÂRLAN V., 2009, Flora ilustrată a României, *Ed. Ceres*, București
3. CRISTEA V., GAFTA D., PEDROTTI F., 2004, Fitosociologie, *Ed. Presa Universitară Clujeană*.
4. MARUSCĂ, T., 2019. Contributions to the evaluation of pasture productivity, using the floristic releve, *Romanian Journal of Grassland and Forage Crops*, volumul 19, Pp 33-47, Cluj Napoca.
5. MARUSCĂ, T., ARSENE, G.G., TAULESCU, ELENA, 2019a. Assessment of permanent grassland productivity in Poiana Ruscă mountains (Southwest Romanian Carpathians), *Annals of the Academy of Romanian Scientists: Series on Agriculture, Silviculture and Veterinary Medicine Sciences*, volumul 9, Nr. 1, Pp 62 - 69.
6. MARUSCĂ T., TAULESCU ELENA, ROȘCA V., BĂJENARU B., MEMEDEMIN D., 2019b. Contributions to the Evaluation of Grassland Productivity on the Măcinului Mountains National Park, *Romanian Journal of Grassland and Forage Crops*, volumul 20, Pp 17 - 26, Cluj-Napoca.
7. PĂCURAR F., ROTAR I., 2014. Metode de studiu și interpretare a vegetației pajiștilor, *Editura "Risoprint"*, Cluj Napoca.