CONTRIBUTIONS TO THE ASSESSMENT OF THE PRODUCTIVITY OF GRASSLANDS IN THE HYDROGRAPHIC BASIN OF BISTRIȚA – VÂLCII (OLTENIA)

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Abstract

In the Romanian Carpathians, numerous geobotanical studies have been carried out on the vegetation of primary and secondary permanent grasslands. The vast majority of these studies had as their main objective the identification and classification of grassland associations and less the production of green mass and the quality of fodder needed by homesteads. By evaluating productivity based on floristic surveys, vegetation data are complemented with economic data such as production and pastoral value, presented as case studies in this paper. The productivity of the grasslands in the hydrographic basin of the Bistrița-Vâlcii River with a special biodiversity, of 78 cormophytes on average for the 355 surveys had a production of 6.28 t/ha green mass and 36.7 index of pastoral value. This allows obtaining a production of 3710 liters cow milk per hectare in 160-day average grazing season and a livestock density of 0.55 LU per hectare. The data obtained are used to draw up projects for the development of grasslands and their proper management in the future.

Keywords: *permanent grasslands, pastoral value evaluation, green mass, production of milk*

INTRODUCTION

The evaluation of the productivity of the grasslands is absolutely necessary for the preparation of pastoral development projects (Maruşca et al., 2014).

For this major economic objective are the well-known direct methods of harvesting the production of green mass and detailed chemical analysis of fodder quality (Motcă et al., 1994).

Direct determination of the production of grasslands used by grazing is done mostly in fenced areas with rather high expenses and more expensive laboratory analyses.

Along with the evaluation of the production of green fodder mass and the pastoral value based on a well-prepared floristic survey, the productivity of a glassland can be evaluated with quite high accuracy (Maruşca, 2019).

So far, a number of 33 mountain massifs from the Carpathians and 19 resorts from the plain area of Romania have been evaluated in terms of productivity,

based on which a first approximation of the grassland habitats at the European level was made (Maruşca, 2022 a,b).

For this purpose, several thousand floristic surveys existing in the Romanian specialized literature (scientific articles and syntheses, doctoral theses, books, etc.) were studied, to which, for completion, the new evaluation method based on geobotanical data was applied, some also published in this journal (Marusca et al., 2021; Taulescu el al., 2022). The present work is a continuation of the evaluation of grassland productivity at the level of phytosociological associations and alliances, for the second approximation of evaluation with a higher degree of precision.

After a larger number of assessments and an increase in the precision of the productivity of grassland habitats, we will be able to compare them with other habitats at the Balkan and European level. Finally, these economic indicators serve for the development program of the mountain area.

MATERIAL AND METHOD

For The working material for the evaluation of productivity was a doctoral thesis entitled "Floristic and geobotanical study of the Bistrica - Vâlcii Watershed" drawn up in 1974 by biologist Gheorghe Gh. Popescu under the guidance of prof. university Traian Ștefureac from the Faculty of Biology of the University of Bucharest.

The following associations were drawn up:

- VEGETATION OF MESOPHYLOUS GRASSLANDS -
Cls. ***MOLINIO - ARRENATHERETEA*** Tx.1937
Ord. *MOLINIETALIA* W.Koch 1926
Al. ***Agrostion stoloniferae*** Soó (1933) 1940
1. As. *Agrosteto - Poetum trivialis* Soó 1938
2. As. *Alopecureto - Festucetum pratensis* Ujv. 1947
- alopecureto - festucetosum
- pöetosum pratensis Soó 1957
3. As. *Festucetum pratensis* Soó 1938
- festucetosum pratensis
- pöetosum pratensis Soó 1957
- festucetosum valesiacae nova subass
4. As. *Pöetum silvicolae* Buia, Păun, Safta et Pop 1959
5. As. *Agrostetum caninae* Harg 1942
6. As. *Caricetum distantis-vulpinae* Todor 1947
7. As. *Ranunculeto (strigulosi) - Equisetetum palustris* nova ass.prov.
Ord. *ARRHENATHERETALIA,* Pawl. 1928
Al. ***Arrhenetherion elatioris*** Br-Bl. 1925, Pavl. 1928
8. As. *Pöetum pratensis* Burd et al. 1956
Al. ***Cynosurion*** Tx.1947 em Jurko 1969
9. As. *Agrostetum tenuis* Szafer, Pawl. et Kulkz.1923

10. As. *Festuco*(*rubrae*) - *Agrostietum* Csűrős et Kaptalan 1964
11. As. *Agrosti - Chamaespartietum sagittalis* Boșcaiu 1970
- VEGETATION OF XEROPHYLOUS GRASSLANDS -
Cls. *FESTUCO – BROMETEA* Br-Bl. 1943
Ord. *FESTUCETALIA VALESIACAE* Br-Bl et Tx. 1940
Al. Festucion rupicolae *(sulcatae)* Soó 1940
12. As. *Botriochloetum ischaemi* Krist 1937
13. As. *Festucetum valesiacae* Burd. et al. 1956
- festucetosum valesiacae
- agrostidetosum Turcu 1970
Al. *Juniperion sabinae* Csűrős et Pop 1964
14. As. *Juniperetum sabinae* Csűrős 1958
Al. *Seslerio - Festucion pallentis* Klika 1937
15. As. *Melico - Festucetum rupicolae* nova ass.prov.
16. As. *Festuco (rupicolae) - Seslerietum coerulentis* nova ass.prov.
Ord. *BRACHYPODIO - CHRISOPOGONETALIA* (Hic 1958) Boșcaiu 1971
Al. *Danthonio - Brachipodion* Boșcaiu 1970
17. As. *Festuco (rubrae) -Danthonietum* (Gancev 1961 n.n), Csűrős, Pop, Hodișan, Csűrős - Kaptalan 1968
Cls. *SEDO - SCLERANTHETEA* Br.- Bl.1955, Moravec 1967
(Pioneer vegetation on gravel and stony soils)
Ord. *THERO - AIRETALIA* Oberd.1957
Al. *Thero - Airion* Tx. 1951
18. As. *Filagini - Vulpietum* Oberd. 1938
19. As. *Ventenata dubia - Xeranthemum festicum* Borza 1950
Cls. *PLANTAGINETEA MAJORIS* Tx. et Prsg 1950
(weeds from hardened land of ruderalized grasslands)
Ord. PLANTAGINETALIA MAJORIS Tx. (1947), 1950
Al. *Polygonion avicularis* Br.- Bl. 1931
20. As. *Cynodontetum dactyloni* Rapeics 1926
21. As. *Polygonetum avicularis* Br.- Bl. 1931
22. As. *Lolio - Plantaginetum majoris* (Linkola1921), Berger 1930
Al. *Agropyro - Rumicion crispi* Nordh. 1940
23. As. *Lolio - Potentilletum anserinae* Knapp 1946
24. As. *Juncetum effusi* Eggler 1933
25. As. *Junco inflexi - Menthetum longifolies* Lohmayer 1953
26. As. *Agrostetum pisidicas* Buia, Păun, Safta et Pop 1959

The floristic surveys and vegetation classification were made according to the method of the Braun - Blanquet Phytosociological School also called Zürich - Montpellier (Anghel et al. 1971; Coldea 1991; Doniță et al. 1992).

The transformation of the scale of appreciation of the abundance - dominance of the species marked with "+" to "5" into participation percentages was carried out according to the new method of evaluating productivity based on floristic survey (Marușca, 2019).

According to this method, two works have already appeared in

this journal, so we will not return to the applied method (Marușca, Taulescu 2021, Taulescu, Marușca 2022).

Based on the durations of average daily air temperatures (A.d.t.), the optimal grazing period was established, described in a synthesis paper (Marușca, 2001).

From these data there is a similarity between the duration A.d.t. equal to or greater than 10 degrees Celsius, with the optimal grazing period at altitude of - 7.5 days /100 m in areas with assured humidity (precipitation, phreatic water, irrigation) from 205 (0-200 m) to 55 days (2000-2200 m).

Table 1

Optimum grazing period with animals of altitude grasslands and milk conversion coefficient per hectare

Altitude	Duration		Grazing season (days)	Transformation coefficient milk/ha
	A.d.t. ≥ 10 °C (days)	A.d.t. ≥ 20 °C (days)		
2000 - 2200	55	0	55	35
1800 - 2000	70	0	70	44
1600 - 1800	85	0	85	53
1400 - 1600	100	0	100	62
1200 - 1400	115	0	115	71
1000 - 1200	130	0	130	80
800 - 1000	145	0	145	89
600 - 800	160	0	160	98
400 - 600	175	0	175	107
200 - 400	190	45	145	89
0 - 200	205	90	115	71
Gradients for 100 m altitude	- 7.5 days (0 – 2400 m)	- 22.5 days (0 – 400 m)	+ 15 days (0 – 400 m) - 7,5 days (400 – 2400 m)	+ 9 days (0 – 400 m) - 4,5 days (400-2200 m)

In areas with a drier climate where we have A.d.t. ≥ 20 degrees Celsius from 0 -200 m alt. with 115 days of grazing, the optimal duration increases by 15 days/100 m alt. up to 400 m alt. after which it gradually decreases by - 7.5 days, having the humidity provided by the more abundant precipitation of the mountain area (Marușca, 2001).Milk production per hectare (Table 1) was calculated according to the formula:

Milk (litres/ha) =
PV x Conversion coefficient
PV = pastoral value

The transformation coefficient is dependent on the duration of the grazing season (Marușca, 2022c), determined in a 25 years' experience with milk cows in Bucegi Mountains.

Pastoral value is a synthetic parameter regarding the production and quality of the grassy carpet of a grassland, widely used in French (Daget, Poissonet, 1971) and English specialized literature, with a working method well known in grassland culture, so it is not necessary to be presented in detail.

RESULTS AND DISCUSSIONS

In the Bistrița-Vâlcii hydrographic basin, based on 355 floristic surveys, 26 phytosociological associations belonging to 10 alliances, 6 orders and 5 vegetation classes were outlined (Table 2).

On average, 78 species of cormophytes were determined in a floristic survey, valued as rich, starting with 14 at As. *Lolio - Potentilletum anserinae* to 174 *Festucetum pratensis*.

Table 1

General data on vegetation, forage structure, production and the pastoral value of grassland phytocoenoses

№.	Association	Surveys (no.)	Cormophyte	Coverage (%)	Species participation (%)		Green mass production (t/ha)	Pastoral value
					Forage	Harmful		
	Al. *Agrostion stoloniferae*							
1.	*Agrosteto - Pöetum trivialis*	4	51	100	74	26	11,63	58,7
2.	*Alopecureto - Festucetum pratensis*	9	76	100	79	21	14,10	68,4
3.	*Festucetum pratensis*	62	174	100	63	17	14,11	69,3
4.	*Pöetum silvicolae*	16	108	100	87	13	14,40	75,1
5.	*Agrostetum caninae*	3	50	100	86	14	9,76	60,5
6.	*Caricetum distantis-vulpinae*	23	109	100	57	43	5,90	34,9
7.	*Ranunculeto (strigulosi)-Equisetetum palustris*	8	50	88	9	79	0,52	4,6
	Al. *Arrhenetherion elatioris*							
8.	*Pöetum pratensis*	14	102	100	77	23	9,38	59,5
	Al. *Cynosurion*							
9.	*Agrostetum tenuis*	17	99	100	79	21	11,10	61,3
10.	*Festuco(rubrae) - Agrostietum*	33	138	100	74	28	9,36	56,3
11.	*Agrosti - Chamaespartietum sagittalis*	36	147	100	62	38	5,99	42,8
	Al. Festucion rupicolae							
12.	*Botriochloetum ischaemi*	19	122	100	21	79	1,49	14,3
13.	*Festucetum valesiacae*	8	97	100	48	52	3,35	28,8
	Al. *Juniperion sabinae*							
14.	*Juniperetum sabinae*	5	43	100	8	92	0,59	5,8
	Al. *Seslerio - Festucion pallentis*							

15.	*Melico - Festucetum rupicolae*	15	79	55	32	23	2,20	16,3
16.	*Festuco (rupicolae) - Seslerietum coerulentis*	7	57	85	52	33	4,20	25,7
	Al. *Danthonio – Brachipodion*							
17.	*Festuco (rubrae) - Danthonietum*	19	110	100	87	13	11,00	59,7
	Al. *Thero - Airion*							
18.	*Filagini - Vulpietum*	15	114	100	30	70	1,80	19,3
19.	*Ventenata dubia - Xeranthemum festicum*	5	69	82	43	39	1,75	27,3
Al. *Polygonion avicularis*								
20.	*Cynodontetum dactyloni*	6	31	82	63	19	2,92	42,2
21.	*Polygonetum avicularis*	4	17	88	84	4	6,59	48,7
22.	*Lolio - Plantaginetum majoris*	6	59	100	89	11	14,54	75,5
Al. *Agropyro - Rumicion crispi*								
23.	*Lolio - Potentilletum anserinae*	3	14	400	16	84	1,19	12,6
24.	*Juncetum effusi*	14	84	100	31	69	3,52	24,7
25.	*Junco inflexi - Menthetum longifolies*	2	25	100	9	91	1,04	4,6
26.	*Agrostetum pisidicas*	2	16	100	18	82	0,74	13,5
TOTAL - AVERAGE		**355**	**78**	**95**	**53**	**42**	**6,28**	**38,9**

The average soil coverage with vegetation is 95%, being rated as very good. The participation of forage species in the grassy carpet averaged 53%, quite low with variations from 8% in *Juniperetum sabinae* to 87% in *Lolio - Plantaginetum majoris*.

Low percentages of only 9% forage species participation were observed in the associations *Ranunculeto (strigulosi) - Equisetetum palustris* and *Junco inflexi - Menthetum longifolies*.

A high percentage of 87% forage plants was recorded for *Pöetum silvicolae* and *Festuco (rubrae) - Danthonietum*.

The degree of participation of forage species in the grass carpet directly influences the productivity of a grassland. Thus, the associations with the highest production (14.40 - 14.54 t/ha) of green mass are *Pöetum silvicolae* and *Lolio - Plantaginetum majoris*, and the lowest (0.52 - 0.59 t/ha) with *Ranunculeto (strigulosi)- Equisetetum palustris* and *Juniperetum sabinae*.

The average production of green mass (GM) of the associations is 6.28 t/ha, being considered quite low. Likewise, the pastoral value (PV) is weak to mediocre, registering an average index of 38.9 at the level of the 28 associations described in this hydrographic basin. With values of 75.1 - 75.5 PV index are the same associations that also record the highest GM productions, likewise the lowest with 4.6 PV are with the lowest GM productions per hectare, presented before. Since data on GM production and PV indices at the level of grassland association are less representative for the characterization of European-level habitats, phytosociological alliances that are easier to assimilate with habitats are further analysed (Gafta, Mountford, 2008). Thus, the 10 alliances with grassland vegetation, located between 200 - 1100 m altitude in the study area, can optimally use 160 days of grazing with animals with an average load of 0.55 LU per hectare (Table 3).

Table 3

Spread of alliances, average green mass production and grazing livestock density index

Alliance	Altitude (m)	Green mass production		Grazing season (days)	Grazing livestock density index (LU/ha)
		(t/ha)	%		
Agrostion stoloniferae	(200)400-600(800)	10,06	177	175	0,88
Arrhenetherion elatioris	250 - 650	9,38	165	170	0,85
Cynosurion	(300)400-800(1100)	8,82	155	165	0,88
Festucion rupicolae	300 - 650	2,42	43	165	0,23
Juniperion sabinae	800 - 900	0,59	10	150	0,06
Seslerio-Festucion pallentis	(650)700-1000(1100)	3,20	56	145	0,34
Danthonio - Brachipodion	500 - 700	11,00	193	170	1,00
Thero - Airion	300	1,78	31	145	0,19
Polygonion avicularis	(300)400-600(700)	8,02	141	175	0,71
Agropyro - Rumicion crispi	300 - 400 (800)	1,62	28	155	0,17
Average	**200 - 1100**	**5,69**	**100**	**160**	**0,55**

With GM productions of 10-11 t/ha it was evaluated in the *Agrostion stoloniferae* and *Danthonio - Brachipodion* alliances that support an optimal load of 0.88 - 1.00 LU/ha in 170-175 days grazing season.The weakest results regarding GM production were assessed in *Juniperion sabinae* and *Agropyro - Rumicion crispi* with 0.59 - 1.62 t/ha supporting a grazing livestock density index of only 0.06-0.17 LU/ha in 150- 155-day grazing season.Similarly, the evaluation of milk production at the level of grassland alliance (habitat) is presented (Table 4.). The highest milk production was evaluated in *Danthonio - Brachipodion* with 6210 liters/ha at 59.7 PV index, and the lowest in *Juniperion sabinae* with 530 liters/ha and 5.8 PV.

On average, at the 10 practical alliances, 3710 liters of milk per hectare was evaluated, having 36.7 PV and a transformation coefficient of 104 for the 160 days optimal grazing season with dairy cows.

Table 4

Pastoral value and yield of possible cow's milk at the alliance level

Alliance	Coverage (%)	Pastoral value (indices)	Milk conversion indices (indices)	Milk production	
				(liter/ha)	%
Agrostion stoloniferae	68	53,1	107	5680	153
Arrhenetheretalia elatioris	77	59,5	104	6190	167
Cynosurion	72	53,5	101	5400	146
Festucion rupicolae	35	21,6	101	2180	59
Juniperion sabinae	8	5,8	92	530	14
Seslerio - Festucion pallentis	42	21,0	89	1870	50
Danthonio - Brachipodion	87	59,7	104	6210	167
Thero - Airion	37	23,3	89	2070	77
Polygonion avicularis	79	55,5	107	5940	160
Agropyro - Rumicion crispi	19	13,9	95	1320	36
Average	**52**	**36,7**	**101**	**3710**	**100**

These economic data are the basis for the drawing up of pastoral development projects and the correct management of permanent grasslands.

CONCLUSIONS

The vegetation of the permanent grasslands in the basin of the Bistrița-Vâlcii River, tributary of the Olt River, is particularly rich in species, recording an average of 78 cormophytes on a survey in the 26 associations belonging to 10 alliances, 6 orders and 5 phytosociological classes.

The average production of green mass was evaluated at 6.28 t/ha average of associations and 5.69 t/ha average of alliances, which allow a grazing livestock density index of 0.55 LU/ha in 160 days of grazing season.

The average pastoral value has an index of 36.7, which allows the production of 3710 liters of cow's milk per hectare during the grazing season, on average on grasslands located between 200 - 1100 m altitude.

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