CONTRIBUTIONS TO THE EVALUATION OF THE PRODUCTIVITY OF PERMANENT GRASSLANDS FROM THE BABADAG PLATEAU (DOBROGEA)

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Abstract

In this paper it is presented a case study for assessing the productivity of permanent grasslands based on floristic relevées. On the grasslands of Babadag Plateau (Tulcea County), with a fairly varied vegetation, 19 grasslands associations were determined belonging to 7 phytocoenological alliances that fall into 4 orders and classes (Festuco-Brometea, Molinio-Juncetea, Puccinellio-Salicornietea, Plantaginetea majoris). At the level of plant association, Lolio-Agrostetum stoloniferae and Lolio-Plantaginetum majoris have the highes productivity with productions of 15-21 t/ha green fodder mass. The lowest productions were evaluated at Koelerio-Artemisietum lerchianae and Trigonello (gladiatae)-Orlayetum with productions of 1.1-1.2 t/ha green mass. Grasslands vegetation shows a particular interest at the level of alliances which most closely resembles with European level habitats. Of these, the most productive ones are Polygonion avicularis and Agrostion albae which have a capacity of 1-1.2 livestock unit/ha in a season of 185 days of grazing. The least productive phytocoenological alliances were Artemisio-Kochion and Pimpinello-Thymion zygoidi with 0.05-0.23 livestock unit/ha loading with animals. These data serve to assess the grasslands from economics point of view, their improvement and rational use, necessary for the preparation and application of pastoral arrangements.

Key words: permanent grasslands, pastoral value, feed production, carrying capacity.

INTRODUCTION

In general, studies and research on grassland vegetation in our country contain little or no data on feed production and their quality. These productivity data of the grasslands are necessary to make the best decisions on their improvement, the evaluation of the optimal carrying capacity and other elements regarding the rational management of this important way of use for animal husbandry.

By developing a new method for assessing the productivity of grasslands based on floristic surveys, older or newer vegetation studies can be compared as an evolution between them and completed with economic data of production and quality necessary for the preparation of pastoral arrangements (Marușca 2019).

In addition, this method of assessment, which is sufficiently precise, can replace the direct determination by mowing of grassland production in fenced test areas, which is more difficult and sometimes impossible to apply in practice.

MATERIAL AND METHOD

As exemplification of the evaluation of the productivity of the grasslands, "*Flora și vegetația Podișului Babadag*" synthesis work was chosen - authors Gh. Dihoru and N. Doniță, published by the Romanian Academy Publishing House in 1970.

In chapter 3 "*Vegetația ierboasă a Podișului Babadag*" pages 163-243, which also include the vegetation of the permanent meadows drawn up by Gh. Dihoru, the following cenotaxones are outlined:

Class ***FESTUCO – BROMETEA,*** Br.-Bl. et Tx. 43
Steppe vegetation
Order *FESTUCETALIA VALESIACAE,* Br.-Bl. et Tx. 43
Aliance *Festucion rupicolae,* Soó 64
Primary:
Ass. *Stipo (ucrainicae)-Festucetum valesiacae* ass. nov.
Ass. *Crysopogonetum grylli dobrogicum* ass.nov.reg.
Ass. *Medicagini-Festucetum valesiacae* Wagner 40
Ass. *Elytrigietum intermediae* prov.
Ass. *Cynodonti-Poëtum angustifoliae* (Rapaics 26), Soó 57
Ass. *Trigonella (gladiatae)-Orlayetum* prov.
Secondary:
Ass. *Bombycilaeno-Botriochloetum ischaemi* ass.nov.reg.
Ass. *Poëtum bulbosae* (Prodan 39, Răvăruț et al.56) prov.
Ass. *Artemisietum austriacae* (Săvul. 27p.p.) Prodan 39
Ass. *Agropyretum pectiniformae* Prodan 39 emend. Dihoru hoc loco
Al. *Artemisio-Kochion*, Soó 57
Ass. *Agropyro-Kochietum prostratae* Zoloymi (57) 58
Al. *Pimpinello-Thymion* Fed.nov.
Vegetation of calcareous hills
Ass. *Agropyro-Thymetum zygoidi* ass.nov.
Ass. *Koelerio-Artemisietum lerchianae* ass.nov.
Ass. *Festucetum callierii* Șerbănescu 65, ined

Class *MOLINIO-JUNCETEA* , Br.-Bl. 49
Mesophilic vegetation
Order *MOLINIETALIA*, W. Koch 26
Aliance *Agrostion albae*, Soó 33
Ass. *Lolio-Agrostetum stoloniferae* prov.

Class *PUCCINELLIO-SALICORNIETEA,* Țopa 39
Vegetation of weak salts
Order *PUCCINELLIETALIA*, Soó 40
Aliance *Juncion gerardi* , Wendelbg. 43
Ass. *Juncetum gerardi,* Wenzl. 34
Ass. *Agrosti-Caricetum distantis,* (Rapaics 27), Soó 30

Class *PLANTAGINETEA MAJORIS*, Tx. Et Prsg.50
Vegetation of trampled places
Order *PLANTAGINETALIA MAJORIS*, Tx (47)-50
Aliance *Polygonion avicularis*, Br.- Bl. 31
Ass. *Lolio-Plantaginetum majoris* (Lincola 21) Beger 30
Ass. *Cynodonetum dactyloni* (Prodan 1939) prov.

Marsh vegetation (Class *Phragmitetea*) was excluded from the grass layer phytocoenological units, as well as segetal (Class *Secalietea*) and ruderal (Class *Chenopodietea*) vegetation with less or no importance for feed production.

Appreciation of abundance-dominance (AD) of species from the herbaceous layer in the grasslands of Babadag Plateau was performed on the well-known Braun-Blanquet scale, described by Cristea et al. (2004). Conversion of AD assessment notes into percentages according to constancy classes (K) was made after the model initiated by Maruşca (2019) (table 1).

Table 1

Appreciation of participation (P%) from synthetic floristic surveys, depending on the abundance-dominance scale intervals (AD) and average constancy (K%) for phytocoenoses of permanent grasslands (after Maruşca 2019 rebuilt)

AD Scale Br. – Bl.	AD according to 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	7.9	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**

*) Appreciation scale transformation A+D, Braun-Blanquet in percentage, after Tűxen and Ellenberg (1937) in Cristea et all. (2004).

After the transformation of the scale of appreciation of the phytocoenological notations in percentages of participation next to each species from the floristic survey cassified on three large fodder groups: *Poaceae, Fabaceae* and other families, we note feed quality (F4 - F9) and harmful (F1 - F3) indicators along with useful(M1 - M9) and harmful (M0 for F1 - F3) forage phytomass indicators.

The fodder value indices (F) after Kovacs (1979), Păcurar and Rotar (2014) and Maruşca (2019) are the following:

Feed value indices (F):

1 = toxic to animals and humans;
2 = harmful to animal products;
3 = harmful to the vegetal layer;
4 = weak fodder (ballast species);
5 = mediocre fodder (former F1);
6 = medium forage (formerly F2);

7 = good fodder (former F3);
8 = very good fodder (former F4);
9 = excellent fodder (former F5);
X = species of unknown feed value.

The surveys thus prepared with the participation in % of the species in the vegetal layer with the mention of the fodder quality indices (F) and those of useful phytomass (M) make possible the calculation of the pastoral value (VP) according to the formula:

$$VP = \sum P(\%)xF/9$$

in which: VP = pastoral value indicator (0 - 100) according to which the forage quality of a grassland is assessed: 0 - 5 degraded grassland; 5 - 15 very weak; 15 - 25 weak; 25 - 40 mediocre; 40 - 60 medium; 60 - 80 good; 80 - 100 very good.

F = Has values between 4-9

For the evaluation of the net fodder production, a new indirect method of determination was applied based on the floristic surveys and production indices (M) of the fodder species (F4-F9) from the vegetal layer of the grasslands (Marușca 2019).

Calculation formula for the determination of the average green mass production index (IM) of permanent grassland phytocoenoses is the following:

$$IM = \sum P(\%)xM/100$$

in which: M - has values between 1-9 only for values of F between 4-9

After establishing the average green feed mass index (IM) the corresponding interval of the IM value is searched from table 2 and multiplied by the coefficient of transformation into green mass production (CMV), resulting the production in tonnes per hectare and finally the coefficient of appreciation for this indicator.

The green mass production of phytocoenoses is very heterogeneous, starting with 0.2 t/ha (very weak) and can reach over 30 t/ha (excellent) on well-managed and well-exploited permanent grasslands.

Based on these data, the optimal load with animals or carrying capacity (CP) expressed in livestock units (LU/UVM) per hectare are further established using the formula:

$$CP(UVM/ha) = \frac{MV(kg/ha)}{NzxZp}$$

in which: Nz = the daily requirement of grass for 1 livestock unit (UVM), 65 kg (50 kg + 30% (15kg) seasonal climate fluctuations and unconsumed debris)

Zp = number of grazing days (season)

The duration of the optimal grazing season for the Babadag Plateau is on average 185 days.

Table 2

Production indices for feed species and estimating the useful yield per hectare of permanent unfertilized grasslands (after Maruşca, 2019)

Average production indices green mass forage species (IM)	**Coefficients of transformation in green mass production (CMV)**	**Green mass production estimate (MV) (t/ha)**	**Appreciation of production value**
0.1 – 0.5 0.6 – 1.0	x 1.8 x 1.9	0.18 – 0.90 1.14 – 1.90	Very weak
1.1 – 1.5 1.6 – 2.0	x 2.0 x 2.1	2.20 – 3.00 3.36 – 4.20	Weak
2.1 – 2.5 2.6 – 3.0	x 2.2 x 2.3	4.62 – 5.50 5.98 – 6.90	Weak - Medium
3.1 – 3.5 3.6 – 4.0	x 2.4 x 2.5	7.44 – 8.40 9.00 – 10.00	Medium
4.1 – 4.5 4.6 – 5.0	x 2.6 x 2.7	10.66 – 11.70 12.42 – 13.50	Middle - Good
5.1 – 5.5 5.6 – 6.0	x 2.8 x 2.9	14.28 – 15.40 16.24 – 17.40	Good
6.1 – 6.5 6.6 – 7.0	x 3.0 x 3.1	18.30 – 19.50 20.46 – 21.70	Good - Very good
7.1 – 7.5 7.6 – 8.0	x 3.2 x 3.3	22.72 – 24.00 25.08 – 26.40	Very good
8.1 – 8.5 8.6 – 9.0	x 3.4 x 3.5	27.54 – 28.90 30.10 – 31.50	Excellent

Appreciation of carrying capacity of grasslands is done this way:

Units of livestock (UVM)/ha value	**Grassland appreciation**
0.01 – 0.20	Degraded (Degr.)
0.21 – 0.40	Very weak (FS)
0.41 – 0.60	Weak (S)
0.61 – 0.80	Mediocre (Med.)
0.81 – 1.20	Middle (Mijl.)
1.21 – 1.60	Good (B)
1.61 – 2.00	Very good (FB)
Over 2.00	Excellent (Ext.)

These studies extended to a larger number of cenotaxons over large physical-geographical areas can finally be generalized.

In addition, these studies and assessments on the productivity and carying capacity of past permanent pastures can be compared with those of

today in order to dynamically establish their evolution from economics point of view.

RESULTS AND DISCUSSION

Following the calculations performed at the level of the widest spread vegetal association for the steppe grasslands in the Babadag Plateau, it turned out that the least productive are the most degraded, respectively *Agropyro-Kochietum prostratae* association and *Bombycilaeno-Botriochloetum* association with pastoral value (VP) of 6-8, green mass (MV) feed production assessed at 0.6-0.7 t/ha, which supports a load of only 0.05-0.06 livestock units UVM/ha (table 3).

Table 3

Productivity of plant associations of xerophilous grasslands

Plant associations	Pastoral value (VP)	Useful phytomass index (IM)	Green mass production (MV) (t/ha)	Livestock units (UVM/ha)
***Festucion rupicolae* alliance (Primary)**				
Stipo (ucrainicae)-Festucetum valesiacae association	33	2.01	2.42	0.37
Chrysopogonetum grylli dobrogicum association	15	1.04	2.08	0.17
Medicagini-Festucetum valesiacae association	55	3.52	8.80	0.73
Elytrigietum intermediae association	45	4.78	12.91	1.08
Cynodonti-Poëtum angustifoliae association	45	3.74	9.35	0.78
Trigonella (gladiatae)-Orlayetum association	14	0.63	1.20	0.10
***Festucion rupicolae* alliance (Secondary)**				
Bombycilaeno-Botriochloetum association	8	0.38	0.68	0.06
Poëtum bulbosae association	42	0.85	1.62	0.14
Artemisietum austriacae association	25	0.93	1.77	0.15
Agropyretum pectiniformae association	48	2.99	6.88	0.57
***Artemisio-Kochion* alliance**				
Agropyro-Kochietum prostratae association	6	0.32	0.58	0.05

At the opposite pole there are the phytocoenoses from *Medicagini-Festucetum valesiacae* association, *Cynodonti-Poëtum angustifoliae* association and *Elytrigietum intermediae* association with pastoral value (VP) and green mass production (MV) which allow a load of 0.73-1.08 livestock units UVM/ha, considered medium as an appreciation value of the productivity of these steppe grasslands. For other less spreaded mesophilous and halophilous phytosociological associations, trampled places and calcareous hills, the most valuable ones are *Lolio-Plantaginetum majoris* association and *Lolio-Agrostetum stoloniferae* association with pastoral value (VP) of 67-91 (good and very good) green mass production (MV)

about 12-15 t/ha, which allows an optimal loading of 1.2-1.8 livestock units UVM/ha, considered as good and very good (table 4).

The weakest productivity was evaluated at *Koelerio-Artemisietum lerchianae* association which allows a loading of barely 0.05 livestock UVM/ha, followed by *Juncetum gerardi* association with 0.12 livestock units UVM/ha, both considered to be severely degraded or economically insignificant.

Table 4

Productivity of plant associations of mesophilic grasslands, trampled places and calcareous hills

Plant associations	Pastoral value (VP)	Useful phytomass index (IM)	Green mass production (MV) (t/ha)	Livestock units (UVM/ha)
***Agrostion albae* alliance**				
Lolio-Agrostetum stoloniferae association	67	5.20	14.56	1.21
***Juncion gerardi* alliance**				
Juncetum gerardi association	13	0.75	1.42	0.12
Agrosti-Caricetum distantis association	49	2.35	5.17	0.43
***Polygonion avicularis* alliance**				
Lolio-Plantaginetum majoris association	91	6.83	21.17	1.76
Cynodontetum dactyloni association	29	1.02	2.04	0.17
***Pimpinello-Thymion zygoidi* alliance**				
Agropyro-Thymetum zygoidi association	29	1.38	2.76	0.23
Koelerio-Artemisietum lerchianae association	28	0.60	1.14	0.09
Festucetum callieri association	28	2.02	4.44	0.37

For comparison with current grassland habitats, their productivity was assessed (VP, MV and UVM) at the level of phytosociological alliance, which we consider more general and all-encompassing, similar to habitats in the new concept of vegetation classification (table 5).

Table 5

Average productivity of the main permanent grasslands and optimal carrying capacity at the level of phytosociological alliance (habitat)

Phytosociological alliance	Pastotal value (VP)	Green mass production (MV) (t/ha)	Livestock units (UVM/ha)	%
Festucion rupicolae (primary)	35	6.13	0.51	102
Festucion rupicolae (secondary)	31	2.74	0.23	46
Artemisio-Kochion	6	0.58	0.05	1011
Agrostion albae	67	14.56	1.21	242
Juncion gerardi	31	3.29	0.27	54
Polygonion avicularis	60	11.61	0.97	194
Pimpinello-Thymion zygoidi	28	2.78	0.23	46
General average	37	5.96	0.50	100

The highest VP of 60-67 were evaluated at *Agrostion albae* and *Polygonion avicularis* and the lowest of 6-28 to *Artemisio-Kochion* and *Pimpinello-Thymion zygoidi*.

As regards the production assessed by MV at the alliance level the situation is identical with VP, allowing a load of 0.97-1.21 livestock units UVM/ha, considered as medium for *Polygonion avicularis* and *Agrostion albae* respectively 0.05-0.23 livestock units UVM/ha for the least valuable, *Artemisio-Kochion* and *Pimpinello-Thymion zygoidi*.

By comparison, the grasslands from *Agrostion stoloniferae (alba)* alliance from the Măcin Mountains have a grazing capacity of 1.38 livestock units UVM/ha, with 14% higher, and those in Oltenia allow an optimal load of 1.36 livestock units UVM/ha with only 12% more than the Babadag Plateau because the latter are more degraded (Maruşca et al. 2019, 2020).

General arithmetic mean at the level of phytosociological alliances for the Babadag Plateau is presented with a pastoral value of 37 (mediocre), green fodder mass production (net phytomass) nearly 6 t/ha which can maintain 0.5 livestock units UVM/ha in an optimal grazing season.

In the Măcin Mountains located in the north of the Babadag Plateau with a fairly similar grassland vegetation, a pastoral value of 35 is recorded compared to 37 the average in the plateau and an average production of 5.89 t/ha compared to 5.96 t/ha in the plateau, both economics indicators being higher by 1-6% on the plateau compared to the mountain (Maruşca et al. 2019).

This difference is quite small on assessing the productivity of permanent grasslands from the plateau and the mountain, and it confirms to us that the new method applied is correct.

As productivity based on floristic surveys is assessed upon a large number of grassland phytocoenoses it will be possible to draw clearer and clearer conclusions on their economics value, to serve in the end preparation of pastoral arrangements, to improve and sustainably manage this important agricultural activity.

CONCLUSIONS

The permanent grasslands in the Babadag Plateau have a great variability from a phytocoenological and agroproductive point of view, with steppe vegetation, mesophilous and halophilous plant associations, trampled places and calcareous hills.

The highest productivity (pastoral value and fodder production) can be observed with the grasslands belonging to *Polygonion avicularis* alliance and *Agrostion albae* alliance with 60-67 pastoral value (VP) 12-15 t/ha

green fodder mass (MV) which allows an optimal loading of 1-1.2 livestock unit (UVM)/ha in 185 grazing days.

The lowest productivity is evaluated at *Artemisio-Kochion* alliance and *Pimpinello-Thymion zygoidi* alliance with 6-28 pastoral value (VP), 0.6-3 t/ha green fodder mass (MV) which barely allow 0.1-0.2 livestock unit (UVM)/ha in a grazing season.

The average productivity in the Babadag Plateau is 37 in terms of pastoral value (VP), 6 t/ha green fodder table (MV), and an optimal capacity of 0.5 livestock unit (UVM)/ha, calculated for 185 grazing days, with a need of 65 kg green fodder mass (MV)/ livestock unit (UVM)/day.

The data on the productivity of the grasslands through the new method of evaluation based on floristic surveys are used to prepare pastoral arrangements and research on the evolution over time of this main indicator.

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