CONTRIBUTIONS TO THE STUDY OF THE IMPACT OF GRASSLAND PHYTO-COENOSES IN THE UPPER AND MIDDLE TIMIS RIVER BASIN ON FORAGE AND LIVESTOCK PRODUCTION (BANAT, ROMANIA)

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Abstract *. The assessment of forage production on permanent grassland phyto-coenoses based on floristic sampling outlines an economic indicator necessary to establish optimal animal loading. The present paper is a case study for the upper and middle basin of the Timiş River in Banat (Romania), which presents 347 surveys of 27 associations belonging to 15 phyto-sociological alliances from the Semenic, Țarcu-Godeanu and Poiana Ruscă Mountains to the Lugoj Plain, on an altitudinal range of 100-2,190 m. In order to assess production, the grasslands were divided into three main physical and geographical categories, namely: sub-alpine and mountain meadows with an average yield of 3.2 t/ha useful phyto-mass (forage), hill and plain meadows with a production of 6.6 t/ha and flooding meadows, terraces and depressions with a yield of 11.4 t/ha fresh fodder. The most valuable grasslands used by grazing with animals (Al. Cynosurion and Agrostion stoloniferae) can produce 11.7 to 13.8 t/ha fresh fodder which can provide 146-230 kg/ha gain weight in calves and lambs in the optimal grazing season. The meadows used as hayfields (Arrhenetheretum elatioris, Ahopecuretum pratensis, Festucetum pratensis) provide very good yields of 16.8-19.0 t/ha fresh fodder. Several phyto-coenoses located in the sub-alpine level, those invaded by Nardus stricta and Vaccinium sp. in the mountain area or those located on land with permanent moisture excess achieve only 0.3-1.3 t/ha fresh fodder, being considered economically degraded. As a conclusion, the live gain weight of young grazing animals during the grazing season ranges from 20 to almost 200 kg/ha depending by the yield of fresh fodder/ha. This could be a good start for the practice of organic farming in the conditions of proper management. Knowledge of the forage yield of the grassland is extremely useful for drawing up pastoral facilities, preserving biodiversity, and protecting of the environment and pastoral landscapes.*

Keywords: *grassland phyto-coenoses, fresh fodder yield, animal gain weight*

INTRODUCTION

In the study of grassland vegetation, in addition to the determination and classification of phyto-coenoses, an important role has the determining of the productivity expressed by forage quality and fresh fodder yield (BĂRBULESCU & MOTCĂ, 1983, 1987).

The productivity of different types of meadows was studied in Romania from different perspectives (e.g. ARSENE, 1998; COSTE & ARSENE, 2000; DURĂU, CARMEN *et al.*, 2012; HORABLAGA *et al.*, 2012; JURAVLE *et al.*, 2010; NICULESCU, MARIANA, 2004; NICULESCU, MARIANA *et al.*, 2012; VÎNTU *et al.*, 2010; VOȘGAN *et al.*, 2019, STROIA, 2017; STROIA *et al.*, 2011).

Forage quality is most often determined in laboratory from forage samples taken from the certain phyto-coenoses or using pastoral value, a method based on floristic sampling (MOTCĂ *et al*., 1994).

For the determination of grassland production, the ideal method is to fence plots in the field for each vegetal association; the forage from every plot is harvested and weighed. This method is very difficult, even impossible in the current conditions, being the reason why the forage yields are evaluated using the method based on floristic sampling (MARUȘCA, 2019, MARUȘCA *et al.*, 2020).

In this respect, was carried out the summary work on grassland vegetation on an altitudinal interval of about 2,000 m from the Upper and Middle Basin of Timiș River in Banat. By modelling the fresh fodder yield, it was set to convert it into animal production expressed by animal gain weight during the grazing season for calves and lambs.

MATERIAL AND METHODS

In order to determine the grassland yield based on floristic sampling, data from the doctoral thesis entitled "Ecological and phyto-coenological study of grassland vegetation in the upper and middle basin of the Timiș River" (NICOLIN, 2015) was taken into account.

The following coeno-taxonomic units were encountered and studied:

Cls. *JUNCETEA TRIFIDI* Klika et Hadac 1044
Ord. *Caricetalia curvulae* Br-Bl. 1926
Al. *Caricion curvulae* Br-Bl. 1925
As. *Primulo - Caricetum curvulae* Br-Bl. 1926 em. Oberd. 1957
As. *Potentillo chrysocraspedae - Festucetum airoidis* Boșcaiu 1971
As. *Oreochloo - Jucetum trifidi* Szafer *et al.,* 1927
Al. *Loiseleurio - Vaccinion* Br-Bl. 1926
As. *Empetro - Vaccinietum gaultherioidis* Br-Bl. 1926
Cls. *VACCINIO - JUNIPERETEA* Pass. et. Hofm. 1968
Ord. *Junipero - Pinetalia mugi* Boșcaiu 1971
Al. *Pinion mugi* Pawl. 1928
As. *Campanulo abietinae - Vaccinietum* (Buia *et al.,*1962) Boșcaiu 1971
Cls. *OXYCOCCO - SPHAGNETEA* Br-Bl. et Tx. 1943
Ord. *Sphagnetalia magellanici* (Pawl.1928) Moore (1964) 1968
Al. *Sphagnion magellanici* Kästner et Flössner 1933
As. *Eriophoro vaginati - Sphagnetum recurvi* Hueck 1025
Cls. *NARDO - CALLUNETEA* Prsg.1949
Ord. *Nardetalia* Oberd 1949
Al. *Potentillo - Nardion* Simon 1957
As. *Scorzonero roseae - Festucetum nigricantis* (Pușcaru *et al.,* 1956) Coldea 1987
As. *Violo declinatae - Nardetum* Simon 1966
Cls. *BETULO - ADENOSTYLETEA* Br-Bl. et Tx. 1943
Ord. *Adenostyletalia* Br-Bl. 1931
Al. *Rumicion alpini* Rubel 1933
As. *Senecioni - Rumicetum alpini* Horv.1949 em Coldea (1986) 1990
Cls. *MOLINIO - ARRENATHERETEA* Tx.1937
Ord. *Arrenatheretalia* Pawl. 1928
Al. *Cynosurion* Tx. 1947
As. *Festuco rubrae - Agrostietum capillaris* Horv. 1951
Al. *Arrenatherion elatioris* Koch 1926
As. *Festucetum pratensis* Soó 1938
As. *Arrhenatheretum elatioris* Br-Bl. ex Scherrer 1925

Ord. *Molinietalia coeruleae* W. Koch 1926
Al. *Molinion coeruleae* W. Koch 1926
As. *Peucedano rocheliani - molinietum coeruleae* Boșcaiu 1965
Al. *Calthion palustris* Tx.1937
As. *Holcetum lanati* Issler 19336 em. Pass. 1064
As. *Scirpetum silvatici* Maloch 1935 em. Schwich 1944
As. *Epilobio - Juncetum effusi* Oberd 1957
Al. *Agrostion stoloniferae* Soó (1933) 1971
As. *Poëtum pratensis* Răv., Căzăc. et Turenschi 1956
As. *Agrostidetum stoloniferae* (Ujvárosi 1941) Burduja *et al.,* 1956
As. *Medicagini lupulinae - Agropyretum repentis* Popescu *et al.,* 1980
Ord. *Deschampsietalia caespitosae* Horvatič 1956
Al. *Alopecurion pratensis* Pass.1964
As. *Alopecuretum pratensis* Regel 1925
Cls. *TRIFOLIO GERANIETEA SANGUINEI* Th. Müller 1961
Ord. *Origanetalia vulgaris* Th. Müller 1961
Al. *Trifolion medii* Th. Müller 1961
As. *Clinopodio - Pteridietum* Dihoru 1975
Cls. *FESTUCO - BROMETEA* Br - Bl. et Tx. 1943
Ord. *Festucetalia valesiacae* Br - Bl. et Tx. 1943
Al. *Festucion rupicolae* Soó (1929 n.n.) 1940 corr. Soó 1964
As. *Festucetum rupicolae* Burduja *et al.,*1956; corr. Burduja *et al.,* 1972-1973
As. *Festucetum valesiacae - rupicolae* Csürös et Kovacs 1962
Ord. *Brachypodio - Chrysopogonetalia* (Horvatič 1958) Boșcaiu 1972
Al. *Danthonio - Brachypodion* Boșcaiu 1972
As. *Festuco rupicolae - Danthonietum alpinae* Csürös *et al.,* 1961
As. *Danthonio - Chrysopogonetum grylli* Boșcaiu (1970) 1972
Cls. *PLANTAGINETEA MAJORIS* Tx. Et Prsg 1950
Ord. *Plantaginetalia majoris* Tx. (1947) 1950
Al. *Agropyro - Rumicion crispi* Nordh. 1940
As. *Trifolio repenti - Lolietum* Krippelová 1967
As. *Junco - Menthetum* Lohm 1953

This study presents 347 floristic surveys belonging to 27 permanent grassland associations located from 100 to 2,190 m altitude from the Lugoj Plain to Țarcu Peak in the eponymous massif.

For the synthesis of this large amount of data, the meadows were divided from top to bottom into three main physical and geographical categories: sub-alpine and mountain meadows, hill and plain meadows and flooding meadows, terraces and depressions.

In general, sub-alpine meadows are used almost exclusively by grazing with sheep, mountain meadows are mainly used by grazing with cattle and sheep, sometimes by mowing, and flooding meadows are mostly exploited by mowing for hay.

The working method for determining production based on floristic sampling is based on the multiplication of abundance - dominance (%) of the forager species from the vegetal cover with a fresh fodder index from 1 – very low to 9 – very high, result that is then divided by 100. Multiplying this phyto-mass index by a coefficient between 1.8 and 3.5 directly assesses the production of fresh fodder yield in t/ha (MARUȘCA, 2019).

After determining the fresh fodder yield of the grassland used by grazing according to the average altitude where the analysed plots are placed, the optimal grazing time and the feeding requirements for the production of 1 kg of live weight gain in lambs or calves, livestock production was evaluated (Table 1).

Table 1

Duration of the optimal grazing season and the fresh fodder amount for live weight gain in calves and lambs (after MARUȘCA, 2001 updated)

Altitude	Duration of grazing season	Necessary fresh fodder amount for 1 kg of live weight gain
Sub-alpine and mountain grasslands		
2000-2200	55	140
1800-2000	70	130
1600-1800	85	120
1400-1600	100	110
1200-1400	115	100
1000-1200	130	90
800-1000	145	80
600-800	160	70
Hill, plain, flooding meadow and depression grasslands		
400-600	175	60
200-400	175	60
0-600	175	60
Gradients for 100 m altitude		
600-2200	- 7.5	+ 5
0-600	0	0

The conversion to livestock production hasn't been calculated for the degraded grasslands invaded by *Nardus stricta*, *Pteridium aquilinum*, *Vaccinium* sp. and other shrub species, those with permanent excess moisture (peats) and other extreme conditions which determinate very low fresh fodder yields.

RESULTS AND DISCUSSIONS

The meadows from the upper basin of the Timiș River located in the mountain sub-alpine level of the Țarcu-Godeanu and Poiana Ruscă Mountains have a well-defined yield according to the altitude and degradation stage of the vegetal cover (Table 2).

Table 2

Fresh fodder yield of sub-alpine and mountain grassland associations in the upper basin of Timiș River

Phyto-coenosis	Number of samples	Altitude limits (m)	Fresh fodder yield		Use
			t/ha	% compared to mean	
Al. *Caricion curvulae*					
Primulo - Caricetum curvulae	7	2.100-2.190	1.52	47	Pasture
Potentillo chrysocraspedae -	11	840-1.910	3.34	103	Pasture

Festucetum airoidis					
Oreochloo - Jucetum trifidi	7	920-2.150	2.98	92	Pasture
Al. *Loiseleurio - Vaccinion*					
Empetro - Vaccinietum gaultherioidis	5	1930-1960	0.26	8	Degraded pasture
Al. *Pinion mugi*					
Campanulo abietinae - Vaccinietum	16	1310-1800	0.49	15	Degraded pasture
Al. *Sphagnion magellanici*					
Eriophoro vaginati - Sphagnetum recurvi	6	1470-1620	0.27	8	Degraded pasture
Al. *Potentillo - Nardion*					
Scorzonero roseae - Festucetum nigricantis	15	1350-1870	8.28	256	Pasture
Violo declinatae - Nardetum	22	820-1800	1.29	40	Pasture
Al. *Rumicion alpini*					
Senecioni - Rumicetum alpini	5	1300-1750	2.20	68	Pasture
Al. *Cynosurion*					
Festuco rubrae - Agrostietum capillaris	65	500-1400	11.69	362	Pasture, hey field
TOTAL	**159**	**500-2190**	**3.23**	**100**	

Thus, degraded grasslands invaded by woody or non-valuable herbaceous vegetation belonging to *Empetro - Vaccinietum*, *Campanulo - Vaccinietum* and *Violo (declinatae) - Nardetum* have the lowest yields of 0.3-1.3 t/ha fresh fodder. Similarly, the marshy meadows of the association *Eriophoro - Sphagnetum* have a very small production.

Sub-alpine grasslands with yields of 1.5 to 3.3 t/ha fresh fodder are influenced by lower temperatures associated with shorter vegetation season.

More valuable yields of 8.3-11.7 t/ha are registered in mountain grasslands, in As. *Scorzonero roseae - Festucetum nigricantis* and *Festuco rubrae - Agrostietum capillaris.*

In the hill and plain area of the middle basin of the Timiş River, the average production reaches 6.6 t/ha, i.e. more than twice compared with the sub-alpine-mountain level (3.2 t/ha) (Table 3).

Table 3

Fresh fodder yield of hill and plain grassland associations in the middle basin of Timiş River

Phyto-coenosis	Number of samples	Altitude limits (m)	Fresh fodder yield		Use
			t/ha	% compared to mean	
Al. *Trifolion medii*					
Clinopodio - Pteridietum	13	160-950	1.04	16	Pasture
Al. *Festucion rupicolae*					
Festucetum rupicolae	21	100-470	5.70	86	Pasture
Festucetum valesiacae - rupicolae	13	220-400	7.63	115	Pasture
Al. *Danthonio - Brachypodion*					
Festuco rupicolae - Danthonietum alpinae	10	270-370	10.82	164	Pasture
Danthonio - Chrysopogonetum	8	210-350	1.92	29	Pasture, hay field
Al. *Agropyro - Rumicion crispi*					
Trifolio repenti - Lolietum	11	170-350	17.37	263	Pasture
Junco - Menthetum	5	100-340	1.82	28	Pasture
TOTAL	**81**	**100**	**6.61**	**100**	

The smallest yields were registered in the associations *Clinopodio - Pteridietum*, *Danthonio - Chrysopogonetum grylli* and *Junco - Menthetum* with values of 1.0-1.9 t/ha fresh fodder. Greater yields than 7.6-17.4 t/ha fresh fodder were in the associations *Festucetum valesiacae - rupicolae*, *Festuco rupicolae - Danthonieum alpinae* and *Trifolio repenti - Lolietum*. The azonal flooding meadows, terraces and depressions generally have the highest yields with an average of 11.4 t/ha fresh fodder (Table 4).

Table 4

Fresh fodder yield of the azonal associations of flooding meadows and depressions in the middle basin of the Timiş River

Phyto-coenosis	Number of samples	Altitude limits (m)	Fresh fodder yield		Use
			t/ha	% compared to mean	
Al. *Arrenatherion elatioris*					
Festucetum pratensis	12	200-750	18.96	167	Mixed use (grazing – mowing)
Arrhenatheretum elatioris	5	110-400	16.77	148	Mixed use (grazing – mowing)
Al. *Molinion coeruleae*					
Peucedano rocheliani - molinietum coeruleae	25	200-380	1.12	10	Mixed use (grazing – mowing)
Al. *Calthion palustris*					
Holcetum lanati	13	170-700	12.22	108	Mixed use (grazing – mowing)
Scirpetum silvatici	16	100-920	1.48	13	Pasture
Epilobio - Juncetum effusi	16	110-1460	0.78	7	Degraded pasture
Al. *Agrostion stoloniferae*					
Poëtum pratensis	10	140-620	13.32	117	Pasture
Agrostidetum stoloniferae	5	240-250	14.70	129	Pasture
Medicagini lupulinae - Agropyretum repentis	5	110-120	17.36	153	Mixed use (grazing – mowing)
Al. *Alopecurion pratensis*					
Alopecuretum pratensis	7	120-130	16.92	149	Mixed use (grazing – mowing)
TOTAL	**107**	**100-1460**	**11.36**	**100**	

Thus, the phyto-coenoses located in areas with temporary or permanent humidity excess have registered a yield of 0.8-1.5 t/ha fresh fodder.

The largest yields were recorded in the grasslands used as hayfield, the associations from *Holcetum lanati* (12.2 t/ha) to *Festucetum pratensis* (19.0 t/ha), they being the most valuable grasslands from the studied area.

Regarding the grasslands harvested by grazing with animals, the increase in live weight was estimated (Table 5).

Table 5

Forage and livestock productions of grassland phyto-coenoses used by grazing with calves and lambs

Alliance	Mean altitude (m)	Optimum grazing season duration (days)	Forage yield (t/ha)	Loading of fresh fodder forage/ha	Specific consumption (kg fresh fodder/kg gain)	Seasonal weight gain (kg/ha)	% compared to the mean
Sub-alpine and mountain grasslands							
Caricion curvulae	2040	53	2.73	0.79	138	20	29
Potentillo - Nardion	1490	100	4.12	0.63	110	37	54
Cynosurion	910	145	11.69	1.24	80	146	215
Sub-alpine and mountain mean	**x**	**100**	**6.18**	**0.95**	**91**	**68**	**100**
Hill, plain, flooding meadow and depression grasslands							
Festucion rupicolae	270	175	7.43	0.65	60	124	66
Agropyro - Rumicion crispi	200	175	12.51	1.10	60	209	111
Agrostion stoloniferae	215	175	13.79	1.21	60	230	122
Hill plain mean	**x**	**175**	**11.24**	**0.99**	**60**	**188**	**100**

In the alpine and mountain level of the upper basin of the Timiș River, the production of grass converted to live weight gain of grazing animals is 20-146 kg/ha in average, i.e. 68 kg/ha in about 100 days during the grazing season.

Lower, in hills and plains on zonal and azonal grasslands, with about 175 days of grazing, was produced an increase of almost 190 kg/ha per hectare with a load of about 1 unit of fresh fodder/ha.

The data obtained on quasi-natural grasslands, almost without fertilization except the manure from grazing animals, are particularly valuable for the initiation of organic farming practice.

Through proper management (e.g. application of fertilizers) grass production can be easily doubled or even tripled in comparison with the current level.

CONCLUSIONS

The permanent grasslands of the upper and middle basin of the Timiș River extended over an altitudinal interval of over 2,000 m (100-2,190 m) have a large number of plant associations highly differentiated by physical and geographical conditions, respectively climatic and stational conditions.

The fresh fodder yield of the 27 associations studied varies from 0.3 t/ha to 19 t/ha, being influenced by climate in the high mountains, invasion of non-valuable woody and herbaceous vegetation, excess or lack of moisture, overgrazing or abandonment or other causes.

The live weight gain of young animals during the grazing season ranges from 20 to about 200 kg/ha, depending by the fresh fodder yield/ha, making it a good start for the practice of organic farming in the conditions of proper grassland management.

BIBLIOGRAPHY

ARSENE, G.G., 1998 - Studiul ecologic şi fitocenologic al vegetaţiei ierboase de pajişti din Munţii Poiana Ruscă (Ecological and phytocenological study of the grassy vegetation of meadows in the Poiana Ruscă Mountains), Ph.D. Thesis, University of Agricultural Sciences and

Veterinary Medicine, Timişoara, Romania.
BĂRBULESCU, C., MOTCĂ, G., 1983 - Pășunile munților înalți, Editura Ceres, București.
BĂRBULESCU C., MOTCĂ G., 1987 - Pajiştile de deal din România, Ed. Ceres, Bucureşti.
COSTE, I., ARSENE, G.-G., 2000 – Les principaux prairies de Banat (Sud-ouest de la Roumanie) – Synthese phytosociologique, in „Tendances actuelles dans la recherche sur les prairies permanentes" Colloque roumain-francais, 5-7 juin 2000, Timişoara-Braşov, 13.
DURĂU, CARMEN, SĂRĂȚEANU, VERONICA, 2012 - Assessment of biodiversity, pastoral value and carrying capacity of several permanent grasslands from Western Romania, Journal of Biotechnology 161:21.
HORABLAGA, N.M., HORABLAGA, ADINA, COJOCARIU, LUMINIȚA, MARIAN, F., LALESCU, D., BOSTAN, C., 2012 - The productive characters study of some Alopecurus pratensis L. biotypes in the West of Romania, Journal of Biotechnology, Volume 161:20.
JURAVLE, V., COJOCARIU, LUMINIȚA, STROIA, C., LALESCU, D., 2010 - The Dynamics of the Dry Matter Production as a Result of the Mineral Fertilizers Application in a Hayfield from Bistricioara Basin, Analele Universității din Oradea, Fascicula Ecotoxicologie, Zootehnie şi Tehnologii de Industrie Alimentară, Oradea.
MARUȘCA, T., 2001 – Elemente de gradientică şi ecologie montană, Editura Universităţii Transilvania, Braşov.
MARUȘCA, T., 2019 - Contributions to the evaluation of pasture productivity using the floristic releve. Romanian Journal of grassland and forage crops, 19: 33- 47.
MARUȘCA, T., ARSENE, G.-G., TAULESCU, ELENA, 2020 - Assessment of Permanent Grassland Productivity in Poiana Ruscă Mountains (South-West Romanian Carpathians*)*, Annals of the Academy of Romanian Scientists, Series Agriculture, Silviculture and Veterinary Medicine Sciences, Volume 9, Number 1/2020.
MOTCĂ, G., OANCEA, I., GEAMĂNU, LIDIA, 1994 - Pajiştile României, tipologie şi tehnologie, Ed. Tehnică Agricolă, Bucureşti.
NICOLIN, ALMA L., 2015 - Flora și vegetația pajiștilor din bazinul superior și mijlociu al râului Timiș, Ed. Eurobit, Timișoara.
NICULESCU, MARIANA, 2004 - Contributions Regarding the Study of the Nardo-Callunetea Prsg. 1949 Class in the Upper Basin of Luncavăţ River (Vâlcea County), Contribuţii Botanice, XXXIX, Grădina Botanică "Alexandru Borza" Cluj-Napoca.
NICULESCU, MARIANA, GRECU, FLORINA, SILVESTRU NUȚĂ, I., IOVU, I., 2012 - Researches on the meadows from Cynosurion cristati Br.-Bl. et Tx. 1943 in the Bistriţa-Văratec Valley (Gorj County, Romania), Analele Universităţii din Craiova, seria Agricultură – Montanologie – Cadastru Vol. XLII/2/2012
STROIA, C., 2017 - Fonctionnement de l'écosytème prairial. Méthode de diagnostic, Edition universitaire européenne, ISBN : 978-3-330-86584-6.
STROIA, C., MOREL, C., JOUANY CLAIRE, 2017 - Nitrogen Fertilization Effects on Grassland Soil Acidification: Consequences on Diffusive Phosphorus Ions, SSSAJ: Volume 75: Number 1
VÎNTU, V., SAMUIL, C., POPOVICI, C.I., STAVARACHE, M., MUNTIANU, I., 2010 - Management Based on Organic Imputs of a Nardus stricta L. and Festuca rubra L. Meadow from the Dorna Depression, Lucrări Ştiinţifice – vol. 53, Nr. 2/2010, seria Agronomie, University of Agricultural Sciences and Veterinary Medicine, Iaşi.
VOȘGAN, ZORICA, JELEA, STELA, MARIAN, MONICA, MARE ROSCA, OANA, MIHALESCU, LUCIA, 2019 - Assessment of Biomass Production on Pastoral Meadows in the Gutâi Mountains, Bulletin UASVM series Agriculture 76(2) / 2019.