The management of oligotrophic grasslands and the approach of new improvement methods

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Abstract

The performance of a traditional management on the grasslands in Apuseni Mountains (Romania) has generated certain landscape elements, which give a peculiarity to this region. This way of use has created a high phyto-diversity on Ghetari-Poiana Calineasa Plateau in Garda de Sus community. The rigorous knowledge of the traditional use management of oligotrophic grasslands is extremely important in order to maintain theses grasslands within the mountainous landscape and, implicitly, the high phyto-diversity which they shelter. It has been observed that the most frequently practiced maintenance activities are the following: gathering rocks, destroying anthills, fighting against wooden vegetation, controlling weeds and fertilization. The use system is mostly mixed (mowing + grazing), followed by grazing and, lastly, by mowing. Elaborating a calendar of oligotrophic grasslands' use is essential for actual and future actions of phyto-diversity conservation. Grasslands' mulching combined with organic and mineral fertilization could be viable solutions of sustainable use of the oligotrophic grasslands. The productivity of our grasslands - Agrostis capillaris L with Festuca rubra L is very reduced, and by applying technological inputs, no significant growths of dry matter yield can be noticed. The studied phytocenosis has a medium phyo-diversity, and, by applying technological inputs in the first year, no important changes are brought at the sward's level.

Key words: traditional management, phyto-diversity, mulching, organic and mineral fertilization

INTRODUCTION

The grasslands' way of use has implications in productivity, species composition and in the obtained forage quality. In many studies performed on grasslands (especially on the oligotrophic ones) the grasslands management, most of the times, is being ignored and, this actually being the factor that has generated the present status. The management is the one that is creating and maintaining a high phyto-diversity, but it could dramatically reduce it in a short period of time. Recent studies performed by REIF et al., (2005), support this affirmation, revealing that the phyto-diversity of grasslands ecosystems from the Ghețari – Poiana Călineasa Plateau,

Gârda de Sus commune, Apuseni Mountains (the study area) is very rich and is due to the traditional management applied for a long period of time. A negative example of fast decrease of phyto-diversity is given by PĂCURAR (2005), showing that by applying 100 N 50 P_2O_5 50 K_2O (kg/ha) fertiliser, during eight years, the phyto-diversity has considerably reduced (17 plant species have disappeared).

The consequences of the use manner go even further - by the aesthetics of the mountainous cultural landscape. By not applying a traditional management in our study area, it would lead towards the disappearance of numerous landscape elements (piles of rocks, wooden fences, solitary trees etc.), fact that it will considerably deteriorate the peculiarity of the mountainous cultural landscape. Its alteration would generate a remarkable decrease of the area's tourism potential. PFLIMLIN and TODOROV (2003) states that the agro tourism is a possibility to enhance the incomes of the farms situated in mountains like Tatra, Balkans, Tyrol, Carpathiens etc. The activites diversification of the farms took place after imposing the milk quota, when many farms, especially the ones in mountainous areas, had started to practice tourism as a secondary activity. In the French Alps and Pyrenees, 65 % of the summer pastures are crossed by walk paths which serve the agrotourism and ecotourism, with shelters built for tourists, and 15% of them serve for skiing activities. Also, on these grasslands, hunting is performed (PARQUEDDU et al., 2003). The species rich grasslands with various combinations of colours play an essential role in landscape's aesthetics and create a special appearance for it. The colours combinations in natural grasslands, at all levels (from lowland to mountains) are vital signs for a helthy environment (ROTAR, 2003).

The lack of management (grasslands' abandonment) induced by the depopulation of mountainous areas, has also negative effects upon the phyto-diversity and, implicitly, upon the landscape. The respective areas will become afforested and the mountainous cultural landscape will become a "forest". Similar situations happened also in countries of European Community, for example in Switzerland, during 1985 – 1995, 4% of the country's grassland area has suffered afforestation (JEANGROS and THOMET, 2004). The abandonment of the grassland areas in Italy has induced areas' aforestation and, implicitly, the decrease of species biodiversity (LOMBARDI et. al., 2001, SABATINI et. al., 2003, SUSAN and

ZILIOTTO, 2004). The same issue was point out by BIALA and ZYSZKOWSKA (2004) in Poland, HEJCMAN et al. (2004) in Czech Republic. In our research area, the population of Gheţari – Poiana Călineasa Plateau was 2418 inhabitants in 1956, diminishing down to 1478 inhabitants in 2001 (WEHINGER et al., 2005).

After all these, we can state that the secondary grasslands are strongly related to the way of use and, very easily, they can be "driven" by an extreme to another (abandonment – intensive exploitation). That is why, is extremely important to elaborate some "recipes" for the ways of use in order to maintain the secondary natural grasslands within the mountainous cultural landscape. The traditional way of grasslands use is the one that generated a high phyto-diversity and certain landscape elements which offer the peculiarity to the cultural landscape, but this type is less studied. There are different publications which describe the traditional management but most of them are not rigorous studies, but some conclusions drawn by some "tourists" who spent a few days in a certain place, and, in consequence, they have a high degree of partialism.

In order to make a description of some grasslands' traditional way of use, first of all, it needs a long period of time assigned to this action, than a proper questionnaire and a suitable ability to communicate with the locals.

The objectives of this paper are the following:

- describing the management applied on the oligotrophic grasslands from Ghetari - Poiana Călineasa Plateau;
- elaborating a calendar of oligotrophic grasslands use based on the obtained results;
- approaching some new methods for using the oligotrophic grasslands in order to improve the traditional management.

MATERIAL AND METHODS

Our research activity was performed in Gârda de Sus commune from Apuseni Mountains. The description of the management applied on oligotrophic grasslands was performed by using a questionnaire, which contains 79 questions and it was applied to 83 landowners.

The questionnaire contains questions concerning the way of performing the maintenance activities and the grasslands' way of use. The questionnaire's application was performed in

2005-2006 during winter and in spring of 2006.

The experience has been placed in 2009 at 1320 m elevation, using randomized blocks method with 7 variants in 5 repetitions. Species studies had been performed using modified Braun-Blanquét method, and the mowing was done at *Poaceaes* blooming using a spinning mowing machine. Data processing and interpretation was made using variance analysis

RESULTS AND DISCUSSION

All these landscape elements are the result of traditional management's application for a long time. The exploitation system of pastures and hay meadows is rather complex because implies, besides exploitation and maintenance works, locals' seasonal moving towards Călineasa communal pasture. The exploitation system of grasslands begins early in the spring with an extensive grazing around farmsteads. Then, at the end of May, the locals move with the animals on Călineasa communal pasture where they stay until the beginning of July. In July, they return to the village to mow the grasslands in their property.

This activity lasts for approximately one month, and at beginning of August, the locals, along with the animals, return to the communal pasture, where they remain until the conditions become proper for grazing. The majority of the questioned landowners have plots of land for over 20 years (60 positive answers out of 83) (to spare writing space we will further express ourselves more simple in answers interpretation, eg. 60 out of 83).

The maintenance works applied on grasslands are the following: gathering rocks, destroying anthills, fighting against wooden vegetation and weeds, fertilization and others (*Table 1*). Most frequent maintenance activities are rocks gathering (85.5%) and fertilization (80.3%). All maintenance works are manually performed with different tools, and, for fertilisation, animal traction carts are being used (horses). Grasslands' fertilization is only organic (60 out of 60), generally with stable manure having 6 months of existence (57 out of 60), coming from cattle and horses (59 out of 60).

Table 1.

Status of maintenance works application.

QUESTION	ANSWERING POSSIBILITIES	ANSWERS (NUMBER)	ANSWERS (%)
What kind of maintenance works do you apply on grasslands?	Rocks gathering	65	85
	Anthills destroying	52	68
	Wooden vegetation fighting	46	60
	Weed fighting	21	27
	Fertilization	61	80
	Others	11	14
Total		76	100

Information regarding the applied manure quantity was obtained, but they are not real, because the locals never weigh the manure and can neither estimate it. After spreading, the manure is broken up by a „harrow". This harrow is a fir tree with rocks on it and it is drawn by a horse. The unbroken manure is gathered by rake and placed in piles (47 out of 60). Grasslands are mostly used through a mixed way (mowing + grazing) or only through grazing (*Table 2*). The mowing is performed usually manually (62 out of 63), the starting moment is established according to the calendar date (60 out of 63). The mowing height is 2-3 cm (25 out of 63) or scraped (22 out of 63). In general, grasslands are manually mowed (44 out of 63) and one yield per year is obtained (58 out of 63). The grass is dried on the soil (62 out of 63) and the dry matter yield could never been estimated by landowners.

Table 2.

Grasslands way of use

QUESTION	ANSWERING POSSIBILITIES	ANSWERS (NUMBER)	ANSWERS (%)
How do you use the meadow?	Grazing	20	24
	Mowing	2	2
	Mixed	61	74
Total		83	100

Regarding the grazing, the moment to begin is randomly established (57 out of 81) and rarely depending on the grass's height (17 out of 81). The grazing stops at winter coming (54 out of 81). Based on the questionnaire results' interpretation and

previous studies regarding the traditional management, a calendar was elaborated with oligotrophic grasslands' use on the Ghetari - Poiana Călineasa Plateau. The result is summarized and documented as a seasonal work plan (*Table 3*).

The management of oligotrophic grasslands assumes a considerable contribution of human and animal energy through the activities performed manually or with the help of horses' force. Considering that the local population is rather old, soon the oligotrophic grasslands will be abandoned.

The traditional management must be improved in the way that the oligotrophic grasslands and their biodiversity are maintained.

A solution might be the grasslands' mulching combined with organic and mineral fertilization.

The productivity of the respective meadow is very low, situation which explains one of the reasons for the abandonment of oligotrophic grasslands in the area. The low DM (dry matter) yield can be explained through the reduced quantities of rainfall from spring and, of course, through the reduced trophicity of the soil.

The effect of mineral fertilisers' application upon our grassland is very poorly felt at the level of the DM's level (*Table 4*). Even if in some treatments' case a weak yield rising is noticed, the differences do not have statistic insurance.

The same situation is seen also in the case of organic fertilisers' application (*Table 5*).

As result of technological inputs administration, there were no changes recorded at the level of the treated variants' canopy.

That is why, we propose to characterise the species composition of the untreated witness in all five repetitions of the experience (*Table 6*).

The vegetation type of the witness is *Agrostis capillaris* L.–*Festuca rubra L.*

The plants from *Poaceae* family range in cover from 29.25 up to 47.75%. The cover of species *Agrostis capillaris L.* is ranging between 11.25 and 27.5%, and the one of the species *Festuca rubra* L. is 17.5% in all five repetitions.

Also, the persistence (K) of the species is minimum (V). Besides these two *Poaceaes*, *Anthoxantum odoratum L.* is also present, but with a smaller cover ranging from 0.5 to 2.75%. This species occurs in four out of the five relevee.

Table 3.

Seasonal work plan for oligotrophic grasslands

	Month	Activity	Execution	Observations
Spring	March (the end)	Fertilisation	For transport horse carts are used. Spreading is manually performed..	The fertilizer quantities differ very much. The majority of landowners fertilize in spring (38 answers out of 60 possible ones, the others do not fertilize the land). It is 6 months old and mixed with saw dust from wood processing and dried beech leaves which are used as litter in the stables. The manure is spread manually from small piles deposited by horse and cart.
	April	Gathering rocks	Manually	The rocks are frequently deposited in piles at the site's margin.
	April	Destroying anthills	Manually	In general, the anthills are destroyed in spring and rarely in autumn and summer by the landowners, using different tools: hoe, harrow, plough drawn by horses etc.
	April	Controlling wood growth	Manually	Mostly *Salix caprea L, Sorbus aucuparia L* and *Prunus spinosa L* are eliminated.
	April	Crushing applied manure	A horse drags a branch, on which rocks are fixed to make it heavier.	This work is performed generally one week after the manure has been applied (valid for the ones that fertilize in spring). The crushing of manure applied in autumn is performed in spring. Rain determines when work starts.
	April	Gathering uncrushed remnants and beech leaves	Manually by rake	The gathering of uncrushed remnants is generally performed not later than one month after crushing. The uncrushed remnants are deposed in a pile on the area on which they have been gathered. Simultaneous with remnants, the dry beech leaves are gathered.
	May	Weeds fighting	Manually with scythe, reaping with hock and knife	In general, the following species are eliminated: *Colchicum autumnale L, Veratrum album L, Pteridium aquilinum L* and *Arctium lapa L.* This work is done regularly by only a quarter of the respondents (21 out of 83).
	May	Repairing damages caused by wild boars	Manually by hock or rake	The biggest damage is done on meadows. This work is done along the entire year as many times as necessary.
	May	Grazing	-	Some grasslands are grazed only in spring and in autumn (22 of 78 answers) others are grazed from spring to autumn (10 of 78 answers)) and others only in autumn (38 out of 78 answers). The grazing is generally done by cattle and horses. Grazing starts randomly in most cases.

	Month	Activity	Execution	Observations
Summer	July-August	Mowing of meadows	Manually	The oligotrophic meadows are mown at the most once per year at the end of the mowing period. Firstly, the locals cut productive meadows, and then the less productive ones are cut. The mowing height is very low (2-3 cm above soil). The grassland remains sometimes un-mown. The reasons for this are: -the grass is not needed because the locals have already enough from sites that are more productive; -the productivity of the grassland is too low to take the effort to cut it; -the owners didn't manage to cut the grass in time; -the owners are too old to do the exhausting job.
	July-August	Drying grass	Manually	The grass is dried on the surface. This method has a great disadvantage; the nutritional value of hay is quickly lost. The drying time of grass depends very much on the climatic conditions. It is very different from one area to another and less productive meadows have shorter drying times than more productive meadows.
Autumn	September -October	Grazing	-	The grazing is generally performed in autumn, when animals return from the communal pasture (38 out of 78 answers). The grazing animals are generally cattle and horses. The starting point is random. The grass's height is about 5 and 10 cm (estimated by owners). When winter (snow) comes, the grazing stops.
	October	Hay transport	By horse carts	After returning from the communal pasture, the hay is transported and deposited either in sheds, or in large hay stacks.
	October-November	Fertilization	The manure is transported by horse carts and spread manually. Oligotrophic meadows are typically less fertilised than the other meadows.	The quantities of fertilizer differ very much. Some grassland owners administer the manure in autumn (31 out of 60 possible ones). After the transport, the manure is spread or deposited into piles. In spring, it is distributed on the surface and later crushed.

Table 4

The influence of mineral fertilizers on the dry matter yield (2009)

Year	Variant	DM t/ha	%	Difference	significance
2009	Witness	0.34	100	0.0	-
	Mulching 1/year	0.45	130.2	+ 0.10	-
	Mulching 2/year	0.35	101.7	+ 0.01	-
	Mulching 1/year+NPK 25:25:25 (annual)	0.44	127.3	+ 0.09	-
	Mulching 1/year+NPK 25:25:25 (1/2years))	0.27	78.5	- 0.07	-
	Mulching 1/year+PK 25:25 (annual)	0.31	89.5	- 0.04	-
	Mulching 1/year+PK 25:25 (1/2years)	0.19	54.1	- 0.16	-

DL(p 5%) + 0,26 DL(p 1%) + 0,36 DL(p 0,1%) + 0,48

Table 5

The influence of mineral fertilizers on the dry matter yield (2009)

Year	Variant	DM t/ha	%	Difference	significance
2009	Witness	0.83	100	0.0	-
	Mulching 1/year	0.67	80.7	- 0.16	-
	Mulching 1/ year +5t/ha manure	0.94	113.2	+ 0.11	-
	Mulching 1/ year +5t/ha manure 1/2 years	0.7	84.3	- 0.13	-
	Mulching 1/ year +10t/ha manure 1/2 years	0.68	81.9	- 0.15	-
	Mulching 1/ year +10t/ha manure 1/3 year	0.86	103.6	+ 0.03	-
	Witness	0.83	100	0.0	-

DL(p 5%) + 0,26 DL(p 1%) + 0,36 DL(p 0,1%) + 0,48

The *Cyperaceaes* and *Juncaceaes* are poorly represented (*Luzula campestris L* – 0.5%). The *Fabaceaes* have a quite reduced presence being represented by *Trifolium pratense L* (cover: 0.5%, K = I) and *Trifolium repens L* (cover: 0.5 - 2.75%, K = II). The plants from other botanical families (OBF) have a cover ranging from 41 up to 51.25%. Among these, a few species that are present in all five repetitions can be noticed, like: *Pimpinella major* L, *Plantago lanceolata* L, *Rhinanthus minor* L, *Trollius europaeus* L, *Viola canina* L, having in general a low cover – aprox. 2.75%. Certain OBF plants are present in four out of the five repetitions: *Arnica montana* L, *Centaurea mollis* Waldst. et Kit,

Euphrasia stricta D. Wolff ex J.F. Lehm., *Hieracium aurantiacum* L, *Hypericum maculatum* Cran, etc., and some species occur only accidentaly (K = I, II) such as: *Centaurea pseudophrygia* C.A. Mey., *Cirsium erisithales* Jacq., etc. The number of species of the studied phytocenosis is ranging from 20 up to 24. The Shannon index is comprised between 2.079 and 2.469, fact that corresponds to a medium phyto – diversity according to some specialists.

Table 6.

The species composition of the witness in five repetitions of the experience

	Repetitions					Persistence
	R1	R2	R3	R4	R5	
Cover %	85	86	85	82	88	
Species %						
Poaceae	29.25	45.5	45	37.75	47.75	-
Agrostis capillaris L	11.25	27.5	27.5	17.5	27.5	V
Anthoxanthum odoratum L	0.5	0.5		2.75	2.75	IV
Festuca rubra L	17.5	17.5	17.5	17.5	17.5	V
Cyperacee and *Juncaceae*	0.5	-	-	-	-	-
Luzula campestris L	0.5					I
Fabaceae	-	-	3.25	0.5	-	-
Trifolium pratense L			0.5			I
Trifolium repens L			2.75	0.5		II
Other Botanical Families	51.25	42.25	41	45.5	46.25	
Alchemilla vulgaris L		2.75	2.75		5	III
Arabis hirsuta L		0.5	0.5		0.5	
Arnica montana L	27.5		0.5	5	0.5	IV
Centaurea mollis Waldst. et Kit	2.75	0.5		2.75	0.5	IV
Centaurea pseudophrygia C.A.Mey				5		I
Cirsium erisithales Jacq.				0.5		I
Leucantheum vulgare L				0.5		I
Euphrasia stricta D. Wolff ex J.F. Lehm.	0.5	0.5	0.5	0.5		IV
Galium mollugo L				0.5		I
Genistella sagittalis L	0.5					I
Gentianella lutescens J. Holub			0.5	0.5		II
Hieracium aurantiacum L	0.5	0.5	2.75		2.75	IV

	Repetitions					Persistence
	R1	R2	R3	R4	R5	
Hypericum maculatum Crantz		5	0.5	0.5	5	IV
Knautia dipsacifolia Kreutzer	0.5			2.75		II
Linum catharticum L		0.5	0.5			II
Pimpinella major L	2.75	2.75	2.75	2.75	5	V
Plantago lanceolata L	0.5	2.75	0.5	2.75	2.75	V
Plantago media L	0.5					I
Polygala comosa Schkuhr			0.5		0.5	II
Potentilla erecta L	2.75					I
Primula veris L					0.5	I
Ranunculus bulbosus L		0.5	2.75	0.5	0.5	IV
Rhinanthus minor L	0.5	5	2.75	2.75	11.25	V
Rumex acetosa L		0.5	0.5	0.5	0.5	IV
Scabiosa columbaria L	0.5			0.5		II
Silene nutans L		0.5	0.5			II
Stellaria graminea L		0.5	0.5	0.5		III
Trollius europaeus L	2.75	5	11.25	5	5	V
Thymus pulegioides L	5	11.25	5	11.25		IV
Vaccinium myrtillus L	2.75					I
Veratrum album L	0.5				0.5	II
Veronica chamaedrys L		2.75	2.75		2.75	IV
Viola canina L	0.5	0.5	2.75	0.5	2.75	V
Number of species	21	21	24	24	20	
Shannon Index	2.095	2.079	2.311	2.469	2.290	

CONCLUSIONS

The management applied on oligotrophic grasslands from Gârda de Sus commune is a traditional one.

The maintenance activities are only manually performed, among them the fertilisation with stable manure being the most important one.

The most frequent using system is the mixed one. Application of organic and mineral fertilisers in the first year of experiences placing was not noticed at the level of DM yield.

The grassland type of the untreated witness is *Agrostis capillaris L – Festuca rubra L.* The species diversity of the studied phytocenosis is medium, and the number of species ranges from 20 up to 24.

Acknowledgments

The studies were performed within the project PN II IDEI 1090 finaced by CNCSIS (Consiliul National al Cercetarii Stiintifice din Invatamantul Superior) Romania and the project Conservation of Eastern European Medicinal Plants: *Arnica montana* L in Romania, initiated by WWF and financed by Darwin Innitiative.

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