RESEARCHES ON RATIONAL UTILIZATION OF IMPROVED GRASSLANDS FROM MOUNTAIN REGION

Vasile Adrian BLAJ[1], Teodor MARUSCA[2], Emil Ciprian HAS[3],

Abstract. *The inappropriate utilization of mountain grasslands, absence of improving works and fertilization, etc., had leaded to degradation, on various stages of grassy carpet, due to the invasion of species with low nutritional value. Among those are the degraded Nardus stricta grasslands, spreaded on large surfaces. In this paper are shown the results on botanical composition, fodder quality, milk quantity and quality, agrochemical indices, etc., obtained on Nardus stricta grasslands improved by different methods starting from 1995 and rationally used for 18 years. Researches have been carried out at Research Base for Mountain Grasslands (RBMG) Blana-Bucegi, at 1800 m altitude, in Bucegi Plateau on a slight tilted terrain with Eastern exposure located at the base of Blana Peak (1875 m). The improving methods had profoundly changed the botanic composition from experimental field, influencing positive the milk production, that reached values up to 3,8 times higher at improved plots compared with the control variant.*

Keywords: *Nardus stricta* grasslands, improving, milk production, quality

1. Introduction

Animal husbandry on subalpine grasslands is a very important economical solution to use these forage resource [3].

The domestic animals kept on those pastures for 80-100 days are providing better productions compared to the ones from lower altitudes, with no other supplementary feeding, excepting the fodder from grasslands [1, 4].

Transhumant herding is still present and has even intensified on the accessible mountains, like Bucegi Massif [2].

On these surfaces it can be used improvement methods, determining higher yields, a substantial improvement of botanical composition and implicitly of fodder quality [6, 7].

[1]PhD, Eng., Scientific Researcher III, Scientific secretary: Research and Development Institute for Grassland Brasov, (blajadi@yahoo.com).
[2]PhD, Eng., General Director: Research and Development Institute for Grasslands Brasov, Corresponding member Academy of Romanian Scientists (maruscat@yahoo.com).
[3]PhD, Eng., Scientific Researcher: Research and Development Institute for Grasslands Brasov, (has_emil@yahoo.com).

An example on improvement measures and rational use by cow grazing the subalpine grasslands it can be found at Research Base for Mountain Grasslands (RBMG) Blana Bucegi.

RBMG Blana Bucegi is located on the Bucegi Mountains Plateau, on the South side, between Blana (1875 m) and Nucet (1863) Peaks, at an altitude of 1800 m with a slight slope and Eastern exposure (Photo 1).

Photo. 1. Image of location of Research Base for Mountain Grasslands (processed image, www.bing.com/maps)

2. Material and method

Experimental plots (Photo 2):

1. **Plot Ac**: *Nardus stricta* natural grassland fertilized with:
   - 200 kg /ha N + 100 kg /ha P_2O_5 +100 kg/ha K_2O in 2000
   - 150 kg /ha N + 75 kg /ha P_2O_5 +75 kg/ha K_2O in 2001
   - 100 kg /ha N + 50 kg /ha P_2O_5 +50 kg/ha K_2O in 2002
   - 150 kg /ha N + 100 kg /ha P_2O_5 +100 kg/ha K_2O in 2010
   - 100 kg /ha N in 2011
   - 50 kg /ha N in 2012
2. **Plot B**: *Nardus stricta* natural grassland fertilized with 150 kg/ha N + 75 kg/ha P_2O_5 + 75 kg/ha K_2O over a period of three years (1996-1998), followed by paddocking with dairy cows in 2004 and 2010.

3. **Plot C**: *Nardus stricta* natural grassland limed up to 2/3 from hydrolytic acidity (in 1995), fertilized in three years (1996-1998) with 150 kg /ha N + 75 kg /ha P_2O_5 +75 kg/ha K_2O, followed by paddocking in 2003 and 2009
4. **Plot D**: sown grassland, limed in 1995, fertilized with minerals (NPK) in 1996-1998 period identic as B and C plots, followed by paddocking with cows in 2002 and 2008

Sown mixture consists in: *Phleum pratense* Favorit variety (40%), *Festuca pratensis* Transilvan variety (25%), *Lolium perenne* Marta (5%), *Trifolium hybridum* – Brasov local variety (15%), *Lotus corniculatus* Livada (15%).

5. **Plot T**: *Nardus stricta* grasslands, rationally used within 30 years, located in the interior of experimental field from Research Base for Mountain grasslands Blana Bucegi.

All experimental plots have been grazed by dairy cows, Schwyz breed (Maramures Brown), adapted to harsh mountain conditions, with a proper health situation and a uniform milk production (12-14 l/livestock unit), being excluded the primiparous cows and the old ones.

Grazing system was free (continuous), with a stocking rate of 4 livestock units (LU) per hectare (3 cows/plot) in Ac, B, C and D and 1,5 LU/ha in T plot.

Photo. 2. Experimental plots from Research Base for Mountain Grasslands (photo by V.A. Blaj)

In order to determine the yield and to take samples for assessing the fodder quality there have been placed 3 cages, in all experimental plots, each with a 2 square meters surface in three replicates.

The harvesting was done once a year, in the first decade of August, during the blooming of grass species.

Chemical analyses in order to determine de fodder quality have been done at the chemical laboratory from Research and Development for Grasslands Brasov and the soil samples by the Office of Pedological and Agrochemical Studies Brasov.

The milk production/ dairy cow was determined on every week by measuring the milk quantities from the milking process on Wednesday evening and Thursday morning.

For determining the quality for each experimental year, once every two weeks, milk samples have been taken,. The samples have been analyzed in order to determine the main physicochemical parameters, using a quick milk analyzer, Ekomilk Total type.

3. Results and discussions

3.1. Yield and the fodder quality obtained in 2013

Dry matter yield (DM) obtained for each experimental plot registered a great variation. DM had values between 1,42 t/ha, for T plot (control – natural grassland) up to 3,74 t/ha, for D plot (sown grassland) with an average of all plots of 2,84 t/ha. The differences between the yields from improved plots, compared to the control plot are statistically assured at DL 0,1% - very significant positive difference (Figure 1). Differences registered also between the improved plots. Thus the difference between D and Ac plots was of 0,70 t/ha and 0,92t/ha between D and B plots.

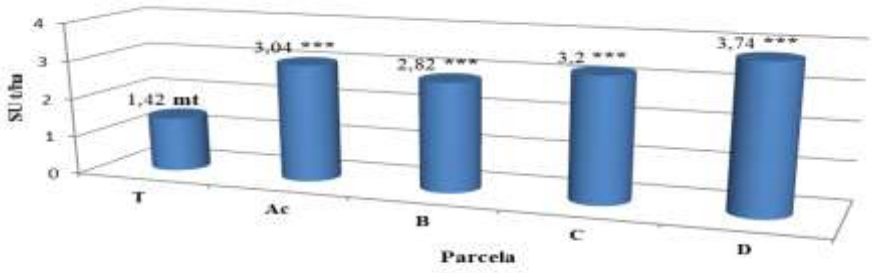

Fig. 1. Dry matter yields of experimental plots, Blana, Bucegi 2013

After the quantitative determinations, to estimate the fodder quality, each weighing 200 g, from all cages located in the experimental plots, samples have been taken.

The nutrients have been determined using the Gerhardt System for determining the fiber fractions and total nitrogen, the organic matter digestibility coefficients by Near Infrared Spectroscopy (NIRS)

The results (average for every plot) of chemical analyses of fodder samples as well as the DM yield are shown in table 1.

Table 2. Results of chemical analyses from the experimental plots, Blana Bucegi, 2013

Plot	*Dry matter, t/ha*	*Crude protein,%*	*Ash, %*	*Crude fiber,%*	*ADF,%*	*ADL,%*	*NDF,%*	*DMD,%*	*OMD,%*
T	1.42	12.53	8.73	27.30	30.83	3.30	50.07	69.77	66.57
Ac	3.04	12.67	8.00	29.90	34.43	4.00	54.20	61.73	58.10
B	2.82	11.70	7.57	32.13	36.70	4.10	56.40	61.33	57.80
C	3.20	12.53	8.30	28.77	33.20	4.10	52.53	65.37	61.57
D	3.74	12.33	7.33	30.50	34.60	3.40	53.87	65.40	61.63
Average	2.84	12.75	7.99	29.72	33.95	3.78	53.41	64.72	61.13

Crude protein content registered small variation between experimental plots, ranging from 11,70 to 12,67%, characterizing a fodder with a medium nutritional value. But regarding the DM obtained at each plot, the crude protein quantity was of 461 kg/ha at D plot (sown – fertilized - limed) meaning with 159% higher than control plot – T (Table 6). Mineral content had values around 8% with variations between 7,33% at D plot and 8,73% (T plot).

Cellular walls content (ADF, NDF, ADL) registered small variations. The average NDF content was 53,41% of DM, with small variations (50,07% – 56,40%) characterizing a fodder with a medium nutritional value. Dry matter digestibility (DMD) coefficients of analyzed samples had medium to good values (61,33-69,77).

The nutritional values of analyzed samples were medium due to the advance vegetation phase when the samples were taken. We have to keep in mind that the samples have been taken from un-grazed surfaces and the values are just as guides. The fodder consumed by animals surely has a higher nutritional value, considering the possibility of a selective and repeated grazing of species with higher nutritional values and so with a better digestibility.

3.2. Botanical composition of the grassy carpet and the soil agrochemical indices

The use of technological methods on subalpine grasslands had led to a change of botanical composition, by the appearance of species with a higher pastoral value, and the improvement of nutritional condition for present species and the reduction of *Nardus stricta* participation rate on grassy carpet.

Table 3. Botanical composition of improved *Nardus stricta* grasslands after 18 years of grazing, Blana Bucegi, 2013

% participation

Species	***Plot***				
	T	**Ac**	**B**	**C**	**D**
GRASSES total	**74**	**68**	**69**	**65**	**74**
Spontaneous	74	68	69	65	64
Nardus stricta	15	2	4	-	-
Festuca nigrescens	20	10	12	17	2
Festuca ovina	5	2	+	+	+
Agrostis rupestris	10	8	7	1	3
Agrostis capillaris	+	7	18	13	32
Phleum alpinum	2	8	5	4	+
Poa media	5	22	2	2	+
Poa pratensis	13	+	14	26	23
Poa annua	+	+	+	+	-
Anthoxanthum odoratum	+	6	+	+	-
Deschampsia flexuosa	2	3	2	+	-
Deschampsia caespitosa	+	+	5	3	4
Sown	**2**	**-**	**-**	**-**	**10**
Phleum pretense	2	-	-	-	7
Festuca pratensis	-	-	-	-	3
LEGUMINOASE total	**6**	**4**	**8**	**15**	**18**
Trifolium repens	6	4	8	15	18
OTHER FAMILIES total	**20**	**28**	**23**	**20**	**8**
Potentilla aurea	7	4	3	1	+
Ligusticum mutellina	10	5	2	1	+
Ranunculus montanum	1	1	+	2	2
Polygonum bistorta	1	15	15	12	1
Hieracium aurantiacum	+	+	+	+	-
Campanula napuligera	1	2	1	1	+
Taraxacum officinale	+	+	2	2	2
Achillea millefolium	+	+	+	+	+
Alchemilla sp.	+	+	+	1	3
Other species	+	1	+	+	+
***Pastoral value**)**	**40**	**26**	**42**	**52**	**61**

*) Good: 50-75 points; Medium: 25-50 points; Low: 5-25 points

At limed plots (C and D) *Nardus stricta* species is totally replaced by valorous spontaneous species (C plot) or sowed species (D plot). A diverse botanical composition can ensure a milk with special organoleptic qualities. The degree of participation of white clover (*Trifolium repens*) in the grassy carpet has growth, reaching values of 15 to 18%, with good influence on fodder quality and on biological nitrogen fixation.

Another positive aspect is the participation degree of Kentucky bluegrass (*Poa pratensis*), that reaches values of 13% to 26%, a species with good fodder qualities for the subalpine climate.

The pastoral value (PV) of experimental plots, in according with the nutritional value of the species from grassy carpet ranged between 26 to 52%. The D plot (fertilization – liming - sowing), with a PV = 61 points and C plot (fertilization - liming), with a PV of 52 points, are remarkable. These values prove the higher level of fodder quality for studied grasslands, when liming is used along with other improvement methods.

As a result of improvement methods and rational utilization, also modifications on the soil chemical composition are appearing (Table 3).

The soils are still having a strong acid pH (5,1) with a high content of mobile aluminum (2,14).

It can be seen a substantial growth of phosphorous content in soil as a result of chemical fertilization and paddocking. Regarding the potassium, the content in soil for this element is variable with no correlation with experimental plots.

Table 4. Soils agrochemical indices from experimental plots, Blana Bucegi, 2013

Plot	***Analysis / MU***								
	pH	Al me/ 100 g soil	Ah me/ 100 g soil	SB me/ 100 g soil	V %	H %	TN %	P ppm	K Ppm
T	5,1	1,740	14,9	8,7	36,8	9,54	3,51	22,0	116,5
Ac	4,8	3,640	23,5	10,8	29,7	12,15	3,60	25,5	148,0
B	4,9	3,440	22,1	10,4	32,0	15,39	4,92	46,0	237,0
C	5,5	0,460	13,5	19,9	59,5	12,60	7,49	106,0	250,0
D	5,2	1,400	23,3	11,2	32,4	10,26	3,32	37,0	240,0
Average	5,1	2,136	19,46	12,2	38,08	11,988	4,568	47,3	198,3

3.3. Milk production

Within the grassland utilisation, presentation of the results in animal product units (ex. milk quantities, live unit gain, etc.) permit us to evaluate more objectively the economic potential of those surfaces.

In Table 4 it is showed the milk production evolution during the grazing season (72 days in 2013) from the subalpine grasslands on RBMG Blana, Bucegi. The average milk quantity varies from one decade to other, being higher on the first 4 decades (11,2 – 13,8 liters/day/dairy cow) and lower on the last 4 decades (6,2 – 8,9 l/day/dairy cow).

Fat and protein productions registered the same variation as milk production. This is due to the fact that the fat and protein content had very small variation during the grazing season.

Table 5. Average cow milk production, Blana Bucegi, 2013

(Grazing period – 72 days)

Mounth	***Decade***	***No. of days***	***Plot***					*Average*
			T	**A_C**	**B**	**C**	**D**	
June	II (12-20)	9	10,7	14,3	13,5	15,3	15,0	13,76
	III (21-30)	10	10,1	12,0	11,4	12,3	14,1	11,98
	Average	**19**	**10,4**	**13,1**	**12,4**	**13,7**	**14,5**	12,82
Julie	I (1-10)	10	9,8	12,5	11,6	14,3	15,0	12,64
	II (11-20)	10	9,3	10,8	9,5	12,1	14,2	11,18
	III (21-31)	11	8,1	7,6	8,4	10,1	10,5	8,94
	Average	**31**	**9,0**	**10,2**	**9,8**	**12,1**	**13,1**	10,86
August	I (1-10)	10	7,3	8,7	8,4	9,3	11,0	8,94
	II (11-20)	10	6,6	7,3	7,2	8,6	9,3	7,80
	III (21-22)	2	5,2	5,6	6,3	6,7	7,2	6,20
	Average	**22**	**6,8**	**7,8**	**7,7**	**8,7**	**9,9**	8,17
Average (Total)		**72**	**8,7**	**10,2**	**9,8**	**11,5**	**12,5**	10,56
Animal load LU/ha			**1,5**	**4**	**4**	**4**	**4**	
Milk production over 72 days			**943**	**2938**	**2825**	**3324**	**3606**	

From the study of milks physicochemical characteristics resulted that over the all grazing period, the values are in normal limits, with no notable differences between experimental plots (Table 5). The difference is registered only from quantitative point of view.

Table 6. Cow milk analyses results, Blana Bucegi, 2013

Plot	Fat %	DMF*) %	Density	Protein %	Freezing point ^{0}C	Lactose %	pH
T	3,60	8,58	1,0285	3,24	-0,564	4,71	6,62
Ac	3,95	8,66	1,0286	3,27	-0,567	4,72	6,67
B	3,86	8,74	1,0292	3,31	-0,571	4,66	6,64
C	4,03	8,81	1,0290	3,33	-0,574	4,82	6,63
D	3,61	8,67	1,0290	3,27	-0,569	4,76	6,62
Average	3,81	8,69	1,0289	3,28	-0,569	4,73	6,63

***)** Dry matter without fat

3.4. Feed conversion efficiency in milk production

Researches carried out over different altitudinal levels estimated that the milk production for every individual animal drops with 0,4l/100 m due, mainly, to climatic conditions. On those conditions, the specific intake for producing one liter of milk grows with 0,05 kg DM/l for each 100 m altitude, thus from approximately 10.000 l/ha produced at 600-800 m, reaches only 5.000 l/ha at 1600-1800 m altitude for a grazing period of only 85 days [5].

In 2013 on subalpine grasslands it was registered a conversion ratio better than the one from 2012 (Table 6). The average dry matter intake for producing a liter of milk was of 1,1 kg. At the improved plots the feed intake was of 1,0 kg and at control plot of 1,5 kg/l. Analyzing the protein conversion ratio, results an average intake of 137 grams for a liter of milk, with variations ranging from 117 to 189 g depending on the experimental plot. For one kg of fat it takes, on average, 29 kg of DM, lower in case of improved plots (24-29 kg DM/1 kg of fat). Average protein conversion ratio is of 4,0/1, lower (3,3/l) at D plot and higher (5,7/l) at control plot (T).

Table 7. Feed conversion ratio indices on subalpine grasslands, Blana Bucegi, 2013

Specification	MU	Plot					Average
		T	Ac	B	C	D	
DM yield	t/ha	1,42	3,04	2,82	3,20	3,74	2,84
	%	100	214	199	225	263	x
CP yield from fodder	kg/ha	178	385	330	401	461	351
	%	100	216	185	225	259	x
Milk production	L/ha	943	2938	2825	3324	3606	2727
	%	100	312	300	3352	382	x
Fat from milk	kg/ha	34	117	109	136	131	105
Milk protein	kg/ha	31	97	94	111	118	90
Kg SU for 1 L milk	Kg/L	1,5	1,0	1,0	1,0	1,0	1,1
g PB for 1 L milk	g/L	189	131	117	121	128	137
Kg SU for 1 Kg fat		42	26	26	24	29	29
Protein ratio from fodder/ milk protein		5,7/1	4,0/1	3,5/1	3,6/1	3,3/1	4,0/1

Conclusions and recommendation

By promoting the improvement methods and rational utilization of subalpine grassland from Research Base for Mountain Grasslands (RBMG) Blana Bucegi, with dairy cows, have been obtained dry matter yields ranging from 1,42t/ha at control plot up to 3,74 t/ha at sown grassland; milk production was of 943 l/ha at the control plot and of 3606 l/ha at the plot sown-limed-fertilized.

Establishment of reseeded pastures (var. D) in specific sub-alpine conditions of degraded grasslands by *Nardus stricta* species, cane by an indirect solution to protect biodiversity in the mountainous area. Such, it can achieve a higher animal stocking rate in these areas, avoiding the animal access in the protected area where there are rare species (endemism) and grazing is prohibited.

Improvement of permanent grasslands from subalpine level by liming, paddocking combined with mineral fertilization with phosphorous (C plot) represents the combination that we recommend for increasing the yields and also milk production.

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