Annals of the Academy of Romanian Scientists
Series on Agriculture, Silviculture and Veterinary Medicine Sciences
Online ISSN 2344 – 2085 Volume 5, Number 2/2016

CONTRIBUTIONS TO IMPROVE BY PADDOCKING WITH CATTLE OF SUBALPINE GRASSLAND FORM THE BUCEGI MOUNTAINS

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Abstract

Permanent grasslands from sub-alpine in the Bucegi Massif located at 1800 - 2200 m altitude have resulted after deforestation of spruce groves (Picea abies) and juniper shrubs (Pinus mugo). Mostly of these grasslands are degraded, being invaded by Nardus stricta species, requiring the improvement operations. In this way researches were carried out by paddocking with sheep and less with cattle, during the grazing season. In 2008 it has been setup an experimental field, with the following experimental factors: the intensity of paddocking 0; 2; 4; 6 nights/cow/6 m2, herbicide, over-seeding and phosphorus fertilization. In the second stage, in 2013, it was paddocked again with an intensity of 4 nights/cow/6 m2, with the purpose to remark the residual effect of improving pasture factors from the first stage. The results highlight the favourable effect for a long period of herbicides, overseeding, phosphorus fertilization and paddocking with cattle on Nardus stricta degraded grasslands. By this method, the degraded grassy carpets have been improved during the first stage by conventional methods, creating optimal conditions for practicing an organic agriculture, after two years of conversion.

Keywords: grasslands of *Nardus stricta* species, herbicides, over-seeding, paddocking with cattle.

INTRODUCTION

For the pastures located in the mountain area or in case of high mountain in subalpine and alpine level, fertilisation by paddocking with sheep and cattle represents the only one and the most efficient method to increase production on an small areas [1] Also, improvement of pastures with degraded cover of *Nardus stricta* species from subalpine level, can be a measure to protection of rare species, meaning that animals can concentrate on improved pastures, while achieving a decrease of grazing pressure in protected zones or even eliminating them from grazing or even eliminate grazing [3].

In the Bucegi Mountains, the first systematic research regarding paddocking on pasture dominated by *Nardus stricta* has been done starting with the year 1952 [6], followed by research regarding overseeding, simultaneously or after paddocking [Maruşca şi Frame, 2003]. Also, similar research has been conducted

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in Țarcu – Godeanu Mountains on 1959 [7], in Portăreasa Mountains from the Masif Iezer-Păpuşa, in 1961 [2], at Padiş in the Bihor Mountains [4].

In all this research actiyity was found efficiency of paddocking with 1 sheep per 1 square meter, during 3 to 6 nights, for increasing the production and quality of grassland invaded by *Nardus stricta* and necesity to practising overseeding on over-paddoked surfaces.

Have not been sufficiently clarified some issues regarding optimal level of paddocking and during of expressions for the effect of improving methods applied.

In this paper we try to contribute with new elements regarding the effect of repeated paddocking applied on surfaces, that was already fertilized with phosphorus, spraying with total herbides and overseeding.

MATERIAL AND METHOD

The experience was carried out at the Research Station for Mountain Grasslands from the Bucegi Mountains, at 1.800 m of altitude in subalpine floor on degraded *Nardus stricta* grassland (40% *N. stricta*).

The experiment was a split plot design with three replicate blocks.

Variants of the experience

Factor A - paddocking 1 cow/6m^2 in years 2008 and 2014, with graduations:

a1 – 2 nights; a2 – 4 nights; a3 – 6 nights;

Factor B - herbicides - with graduations:

b1 – no herbicides; b2 – 5 L/ha glyphosate;

Factor C - phosphorus fertilization, with graduations:

c1 – without fertilisation; c2 – 100 kg/ha P_2O_5;

To these factors is added, like a common treatment, overseeding with a dose of 30 kg/ha and a mixture of perennial grasses and legumes seed consisting of *Festuca pratensis*, Transilvan variety (28%); *Phleum pratense*, Tirom variety (20%); *Lolium perenne*, Marta variety (10%); *Festuca rubra*, Musica, variety (8%); *Lolium multiflorum*, Tirna variety (8%); *Poa pratensis*, Compact variety (4%); *Phalaris arundinacea* Premier variety (2%); *Trifolium pratense*, Pavo variety (8%); *Lotus corniculatus*, Leo variety (8%); *Trifolium repens*, Riesling variety (4%).

In order to determine the green mass production and its quality from each plot were harvested grass samples (1 m^2) in the last decade of July or the first decade of August, when grasses were flowering.

The botanical composition was determined using the method for assessing the percentage of participation in the grassy carpet species (KLAPP– ELEMBERG method). Feed quality analysis has been carried out in the laboratory of chemistry from GRDI Braşov, using the current methodology.

After sampling the grass, the rest of plot area was grazed and then the soil samples were collected, on depth of 0-15 cm, for determining the agrochemical soil indices and their evolution.

Soil quality analyses were carried out at the Office for Soil Science and Agricultural Chemistry Brasov.

The statistical calculation regarding the analysis of variance has been carried out at GRDI Brasov, using the specifically software specific for interpreting of three-factorial experiments placed in subdivided plots.

RESULTS AND DISCUSSION

Dry matter yield

Dry matter yield (DM) is directly influenced by the methods of improvement. Thus, the average for the years 2014-2016 is 2.17 t/ha (table 1) with variations from 1.65 t/ha, at a1b1c2 variant, up to 3.06 t/ha at the a3b2c2 variant. Analyzing the influence of factors to improve separately, we can notice that were obtained at factor A – organic fertilisation by paddocking, average yields of 1.77 t/ha at the 2 nights variant and increasing of production with 21% at 4 nights variant and 45% at 6 nights of paddocking. All of these differences are statistically assured as shown in Table 2. Although, eight years have passed since the factor herbicide was applied, it can be noted that in the 2014-2016 years, average of dry matter production was 8% higher, the differences being statistically assured (table 3).

Table 1. **The average of dry matter yield depending on variants of improvement and years of harvest**

Blana Bucegi, 2014-2016

Variants of improvement			Year			Total
A	B	C	2014	2015	2016	
a1	b1	c1	2.10	1.54	1.43	1.69
		c2	2.35	1.48	1.10	1.65
	b2	c1	2.15	1.78	1.06	1.66
		c2	2.72	2.05	1.51	2.09
a2	b1	c1	3.18	1.78	1.89	2.28
		c2	3.27	1.54	1.39	2.07
	b2	c1	2.60	1.60	1.48	1.89
		c2	2.78	2.51	1.83	2.37
a3	b1	c1	2.88	2.39	1.86	2.38
		c2	3.24	2.00	2.07	2.44
	b2	c1	2.93	2.18	2.16	2.42
		c2	4.05	2.36	2.76	3.06
Total			2.85	1.93	1.71	2.17

Table 2. **Influence of paddocking factor on dry matter production**
Blana Bucegi 2014 -2016

Organic fertilization	DM Production		Difference	The significance
	t/ha	%	t/ha	
a1 - Paddocking - 2 night	1.77	100	Control plot	
a2 - Paddocking - 4 night	2.15	121	0.38	**
a3 - Paddocking - 6 night	2.57	145	0.80	***
DL 5% = 0.15; DL 1% = 0.25; DL 0.1% = 0.47 t/ha				

Table 3. **Influence of herbicide factor on dry matter production**,
Blana Bucegi 2014 -2016

Herbicide	DM Production		Difference	The significance
	t/ha	%	t/ha	
No herbicide	2.08	100	C.p.	
Glyphosate 5L/ha	2.25	108	0.17	*
DL 5% = 0.14; DL 1% = 0.21; DL 0.1% = 0.35 t/ha				

Also, in case of herbicide and phosphorus fertilisation interaction of factors, significant differences were observed. Thus, the combination of factors b1c1(no herbicide - no fertiliser) were obtained 2.12 t / ha SU and the b2c2 (Glyphosate 5L/ha - 100 kg/ha P_2O_5) 2.51 t / ha (table 4).

Table 4. **Interaction of factors herbicides and phosphorus fertilization,**
Blana Bucegi 2014-2016

Herbicide	Fertilization	DM Production		Difference	The significance
		t/ha	%	t/ha	
b1- no herbicide	**c**1 - no fertilization	2.12	100	C. p.	
	c2 - 100 kg/ha P_2O_5	2.05	97	-0.07	
b2 - Glyphosate 5l/ha	**c**1 - no fertilization	1.99	94	-0.13	
	c2 - 100 kg/ha P_2O_5	2.51	118	0.39	***
DL 5% = 0.19; DL 1% = 0.26; DL 0.1% = 0.36 t/ha					

The floristic composition

Improvement methods of nardetum have been profoundly changed the floristic composition in grassy carpet from experimental field.

The table 5 summarizes the average floristic composition for different variants of improvement by paddocking in comparison with mean of experiment. By paddocking applied with 1 cow/6 square meters during 2-6 night and herbicide spraying, are realise a decreasing up to 12% participation of unvaluable species *Nardus stricta* in grass cover. The species *Agrostis rupestris* and *Festuca nigrescens* have been replaced by more valuable sown species like *Phleum pratense*, *Festuca rubra* and *Festuca pratensis*.

In case of herbicide factor, we can notice a significant increasing (+20) of the percentage of participation in grass carpet structure of valuable sown species *Phleum pratense*. Also, the mean pastoral value of herbicide variants is with 12 points superior to the average of no herbicide variants.

When phosphorus fertilization is applied, decreasing of the percentage of participation of plants from other botanical families and increasing of participation of legumes in floristic composition were observed (table 6).

The fodder quality

Analysis of feed quality parameters from pasture (table 7) show that they are within the normal limits in subalpine conditions. Thus, at the contents in crude fiber, ADF (lignocellulose), NDF (fiber plant total) were recorded values quite high, while the content of lignin (ADL) which is a part of the cellular constituents of plants indigestible in the rumen of animals recorded values smaller than 7% (optimum).

The digestibility coefficients for organic matter have varied in small limits, being higher for paddocking with 1 cow /6 m^2 during 2 nights and smaller in case of 4 to 6 nights staying in paddock.

Organic matter digestibility was negatively affected by drought during the growing season, when rainfall was insufficient to ensure the water needs of plants.

Table 5. **Residual effect of paddoking and overseeding on floristic composition , Blana Bucegi (2014-2016)**

SPECIES	Forage quality index	A Factor PADDOKING			Mean of factors 000
		100	**200**	**300**	
Total GRASSES		**78**	**81**	**74**	**78**
a. overseeded species					
Phleum pratense	5	17	20	20	19
Festuca rubra	3	12	14	15	14
Festuca pratensis	5	0	0	1	+
b. spontaneous species					
Festuca nigrescens	3	24	21	17	21
Agrostis capillaris	3	6	8	9	8
Poa media	1	5	4	2	4
Deschampsia caespitosa	0	2	6	4	4
Agrostis rupestris	1	4	4	2	3
Nardus stricta	0	3	2	0	2
Poa pratensis	4	1	2	3	2
Phleum alpinum	2	1	0	1	1
Festuca ovina	1	1	0	+	+
Anthoxanthum odoratum	1	1	+	0	+
Deschampsia flexuosa	0	1	+	0	+
Total LEGUMES		**14**	**9**	**9**	**10**
a. overseeded species					
Trifolium repens	4	12	8	7	9
Trifolium pratense	4	2	1	1	1
Lotus corniculatus	4	+	+	+	+
OTHER FAMILIES		**8**	**10**	**18**	**12**
Potentilla ternata	0	6	5	5	5
Polygonum bistorta	1	0	1	7	3
Ligusticum mutelina	2	1	2	4	2
Ranunculus montanus	0	+	1	1	1
Campanula napuligera	0	1	1	+	1
Campanula abietina	0	+	+	0	+
Alchemilla vulgaris	2	+	+	1	+
Hieracium aurantiacum	0	0	0	+	+
Geum montanum	0	+	0	0	+
Viola declinata	0	+	+	+	+
Other species	**0**	**+**	**+**	**+**	**+**
Pastoral value	**x**	**57**	**57**	**59**	**58**

Table 6. **Residual effect of herbicide and phosphorus fertilisation on floristic composition, Blana Bucegi, (2014-2016)**

SPECIES	Forage quality index	B Factor HERBICIDE			Factor C PHOSPHORUS		
		010	020	Dif. + -	001	002	Dif. + -
Total GRASSES		**75**	**80**	**+ 5**	**78**	**78**	**0**
a. overseeded species							
Phleum pratense	5	9	29	+ 20	17	21	+ 4
Festuca rubra	3	16	10	- 6	15	12	- 3
Festuca pratensis	5	1	+	- 1	1	1	0
b. spontaneous species							
Festuca nigrescens	3	27	13	- 14	21	20	- 1
Agrostis capillaris	3	5	11	+ 6	8	8	0
Poa media	1	3	4	+ 1	6	4	- 2
Deschampsia caespitosa	0	4	4	0	4	4	0
Agrostis rupestris	1	2	5	+ 3	5	3	- 2
Nardus stricta	0	3	+	- 3	2	1	- 1
Poa pratensis	4	+	3	+ 3	1	2	+ 1
Phleum alpinum	2	+	1	+ 1	+	1	+ 1
Festuca ovina	1	1	+	- 1	1	+	- 1
Anthoxanthum odoratum	1	+	+	0	0	1	- 1
Deschampsia flexuosa	0	1	+	- 1	1	+	- 1
Total LEGUMES		**11**	**10**	**- 1**	**9**	**12**	**+ 3**
a. overseeded species							
Trifolium repens	4	9	9	0	8	11	+ 3
Trifolium pratense	4	2	1	- 1	1	1	0
Lotus corniculatus	4	+	+	0	+	+	0
OTHER FAMILIES		**14**	**10**	**- 4**	**13**	**10**	**- 3**
Potentilla ternata	0	5	5	0	5	4	- 1
Polygonum bistorta	1	4	1	- 3	4	1	- 3
Ligusticum mutelina	2	4	1	- 3	2	3	+ 1
Ranunculus montanus	0	+	1	+ 1	1	1	0
Campanula napuligera	0	1	1	0	1	1	0
Campanula abietina	0	+	+	0	+	+	0
Alchemilla vulgaris	2	+	1	+ 1	+	+	0
Hieracium aurantiacum	0	+	+	0	+	+	0
Geum montanum	0	+	+	0	+	+	0
Viola declinata	0	+	+	0	+	+	0
Other species	0	**+**	**+**	**0**	**+**	**+**	**0**
Pastoral value	**x**	**51**	**63**	**+12**	**56**	**61**	**+5**

Table 7. **Results relating to chemical analyses of forage samples, Blana Bucegi 2014-2016**

Variant	**CP** %	**Ash** %	**Crude fiber** %	**ADF** %	**ADL** %	**NDF** %	**DSU** %	**DMO** %
a1	8.63	6.38	38.19	40.74	5.33	65.59	49.70	46.35
a2	9.18	6.89	37.25	39.81	5.17	63.81	51.52	48.21
a3	8.68	6.54	37.80	40.15	5.08	64.71	51.08	47.39
b1	9.05	6.77	37.91	40.53	5.28	64.99	50.15	46.76
b2	8.61	6.43	37.59	39.93	5.10	64.41	51.38	47.86
c1	8.76	6.56	37.96	40.51	5.25	65.16	50.26	46.86
c2	8.90	6.64	37.54	39.95	5.13	64.25	51.27	47.77
Grand total	**8.83**	**6.60**	**37.75**	**40.23**	**5.19**	**64.70**	**50.77**	**47.31**

Agrochemical soil indices

Before placing the experience in 2008, soil samples were taken and analysed to determine the initial chemical composition of the soil. This year a new set of samples was taken. Results are interpreted taking into account the influence of each experimental factor on the soil agrochemical composition (table 8).

Agrochemical soil indices, after 8 years of experimentation, have had important changes as a result of the improvement measures applied. Analysing the modifications of pH indices and content of mobile aluminium, depending on the measures applied, illustrates the following:
paddoking changes soil reaction depending on the used graduation - that meaning it records slight increase in paddocked variants (table 9).

Also, the degree of base saturation are positively influenced by paddocking, so that in the case of 6 nights standing in paddock to be higher with 25%.

Mobile *aluminium content of the soil, which as it is known is toxic to plants, decreased from 6.8 mg / 100 g soil to 2.37 mg / 100 g soil where a paddocking intensity is a cow/6 m2 for 6 nights, this reduction contributing to the improvement of plant* nutrition.

Table 8. **Agrochemical indices of soil, Blana Bucegi (2016)**

Agrochemical indices	MU	2 nights				4 nights				6 nights			
		111	**112**	**121**	**122**	**211**	**212**	**221**	**222**	**311**	**312**	**321**	**322**
pH	ind.	5	5	5	5.1	5	5	5	5	5.1	5.1	5.1	5.3
Al_{mobile}	me/100g	3.172	3.099	3.203	2.350	3.068	3.162	3.141	3.141	2.86	2.808	2.631	1.165
Ah	me/100g	19.8	18.3	18.4	17.1	19.2	23.3	18.8	19.6	18.3	19.5	19.2	14.2
SB	me/100g	11.2	9.2	10.4	9.6	9.4	9.2	9.6	9.4	10.2	9.8	12	12.8
V_{Ah}	%	36.1	33.5	36.1	35.9	32.8	28.3	33.8	32.4	35.8	33.4	38.5	47.4
Hummus	%	15.96	16.08	15.12	14.4	16.92	16.8	16.2	15.48	14.76	16.56	16.2	14.76
N Indice	ind.	5.761	5.386	5.458	5.169	5.539	4.754	5.475	5.015	5.284	5.531	6.237	6.996
P-Al	ppm	24	20.5	17	19.2	22.8	20.5	21	26	18.5	22.8	19	22
K-Al	ppm	104	104	130	128	142	146	128	146	116	132	144	130

Table 9. **Paddocking influence on agrochemical indices of soil, Blana Bucegi (2008-2016)**

Agrochemical indices	MU	Initial		2 nights			4 nights			6 nights		
		2008	%	Ind.	Dif. ±	%	Ind.	Dif. ±	%	Ind.	Dif. ±	%
pH	ind.	4.6	100	5.03	+0.43	109	5	+0.4	109	5.15	+0.55	112
V_{Ah}	%	31	100	35.4	+4.4	114	31.38	+0.38	101	38.78	+7.78	125
Hummus	%	10	100	15.39	+5.39	154	15.57	+5.57	156	16.35	+6.35	164
P – Al	ppm	10.6	100	20.18	+9.58	190	22.5	+11.9	212	20.58	+9.98	194
K – Al	ppm	97	100	116.5	+19.5	120	130.5	+33.5	135	140.5	+43.5	145
Al^{+++}	mg/100g	6.8	100	2.96	-3.84	44	3.13	-3.67	46	2.37	-4.43	35

CONCLUSIONS

(1) The improvement methods of *Nardus stricta* subalpine pastures have profoundly changed the floristic composition of the grassy carpet of the experimental field. Besides that sown species were installed well, it helps to expansion of spontaneous white clover;
(2) Dry matter yield (DM) for the years 2014-2016 was 1.77 t/ha in version 2 nights of paddocking and reach 2.57 t/ha in variant with paddocking a cow/6 nights / 6 square meters, an increase by 45%;
(3) The quality of forages from subalpine improved grasslands, characterised by their specific conditions, is in normal limits. Increase of intensity of paddoking influence positively the forage dry matter digestibility;
(4) Agrochemical soil indices have changed as a result of the improvement measures applied, contributing to the improvement of plant nutrition;
(5) By repeating, from 4-6 t 4-6 years period, of paddocking fertilization method of subalpine pastures, where complex improved measures have been applied is achieved their influence reactivation with beneficial effects on the quantity and quality of feed and animal products and thus economic efficiency of utilisation.

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