

LONG-TERM INFLUENCE OF IMPROVEMENT FACTORS OF MONTANEOUS *NARDUS STRICTA* GRASSLANDS EVALUATED BY FLORISTIC SURVEY

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Abstract

In the Bucegi Massif in the Southern Carpathians at an altitude of 1800 m on a grassland degraded by Nardus stricta, an improvement experiment was set up in 1995, through fertilization, calcium amendment, overseeding and reseeding, which was followed for 28 years, until 2023 and currently. Calcium amendment at 2/3 Ah corrected soil acidity, maintaining it at over 5.0 pH compared to 4.6 pH after 28 years, strongly influencing the evolution of the grassy carpet. Based on floristic surveys carried out annually, the production of green fodder mass and the pastoral value of the experimental variants were evaluated with the factors: A. Mineral (NPK), mineral-organic (tillage) and organic fertilization; B. Grassy carpet, natural, overseeding and reseeding; C. Unamended and amended. The best results were achieved in the calcium-amended variants, mineral fertilized in the first stage followed by the organic ones (night paddocking) or exclusively organic ones, overseeded or natural grassy carpet. In these variants, 14.56 t/ha green mass and 83 forage value index was evaluated based on floristic surveys, which ensured 4250 liters per hectare of cow milk in an 85-day grazing season with cows between 2018-2023, demonstrating the long-term effect of the improvement factors taken into study.

Keywords: *Nardus stricta* grasslands, improvement methods, pastoral value, green mass and milk production.

INTRODUCTION

Permanent grasslands invaded by *Nardus stricta* are the most degraded grasslands in the mountainous area of our country (PUȘCARU-SOROCEANU et al. 1963).

Until now, numerous researches have been carried out to improve them through various surface or radical methods (PUȘCARU et al. 1956, SAFTA et al. 1962, RESMERIȚĂ 1969, SAMOILĂ (coord.) 1979,

BĂRBULESCU, MOTCĂ 1983 and others).

Usually, the duration of these field researches did not last more than 3-5 years, so the evolution over time of the vegetation of the mountain grasslands dominated by *Nardus stricta* was not known (MARUȘCA, 2022).

Following long-term experiments carried out at the "Teodor Marușca" Blana-Bucegi

Mountain Grassland Research Base (BCPM) located at 1,800 m altitude, which belongs to the Grassland Research and Development Institute-Brașov, special results were obtained regarding the evolution of the floristic composition of meadows degraded by *Nardus stricta* following the improvement measures applied.

MATERIAL AND METHOD

Experiments on the improvement of subalpine grasslands located at 1800 m altitude, dominated by *Nardus stricta*, were started in 1995 at BCPM Blana -Bucegi with the following factors and graduations (3x3x2):

Factor A: Fertilization

1. Fertilization with mineral fertilizers (NPK s.a kg/ha)
 - 1996 (150 N, 44 P, 84 K), 1997 (100 N), 1998 (50 N)
 - 2004 – 2006 idem 1996 – 1998
 - 2011 – 2013 idem 1996 – 1998
 - 2018 – 2020 idem 1996 – 1998
 - 2024 – idem 1996
2. Mineral and organic fertilization (night paddocking)
 - 1996 - 1997 chemically fertilized idem A 1
 - 2004 5-night grazing one sheep/sqm
 - 2011 5-night grazing one cow/6 sqm
 - 2018 idem 2011
 - 2024 (to be continued) – idem 2018

In this paper, an evaluation of the influence of improvement factors through fertilization, calcium amendment, overseeding and reseeding is made for the first time, using exclusively annual floristic surveys and synthetic conversion indices based on long-term experiments.

3. Organic fertilization (night paddocking)
 - 1995 5-night grazing one sheep/sqm
 - 2004 idem 1995
 - 2011 5-night grazing one cow/6 sqm
 - 2018 idem 2011
 - 2024 (to be continued) – idem 2018

Factor B: Type of grass cover

1. Semi-natural *Nardus stricta* meadow after clearing of juniper (*Pinus mugo*), a century ago;
2. Overseeded grassland after total herbicide application with "glyphosate" 5 liters per hectare in 1995, harrowed at 2-3 cm and seeded with a mixture of perennial grasses;
3. Reseeded grassland after total herbicide application with "glyphosate", tillage at 10-12 cm depth and seeded with grasses.

Factor C: Calcium amendment

1. Unamended (Control);

2. Amended at 2/3 Ah (7.5 t/ha lime powder CaO);

The floristic composition of the grassland in 1995, before the establishment of the experiment, was as follows: *Nardus stricta* 68%, *Festuca nigrescens* 7%, *Phleum alpinum* 3%, *Agrostis rupestris* 2%, *Festuca ovina* 2%, *Deschampsia caespitosa* 2%, *Anthoxanthum odoratum* 1%, *Deschampsia flexuosa* 1%, *Trifolium repens* 4%, *Potentilla ternata* 5%, *Ligusticum mutellina* 2%, *Polygonum bistorta* 2%, *Campanula abietina* 1%, *Geum montanum* +, *Hieracium aurantiacum* +, *Viola declinata* + and others.

Composition of the herb mixture for overseeding and reseeding: *Festuca pratensis* variety Transilvan 40%; *Phleum pratense* variety Favorit 25%; *Lolium perenne* variety Mara 5%; *Lotus corniculatus* variety Livada 15%; *Trifolium hybridum* Brașov variety 5%, species that are not found in the spontaneous flora.

Mineral fertilization with nitrogen was done with decreasing doses: 150, 100 and 50 kg/ha, imitating as much as possible the effect of animal grazing.

The size of a plot was 18 sqm (6x3), the number of repetitions was 4 and the effective area of the experiment without borders and paths was 432 sqm.

Annual floristic surveys were carried out in two repetitions for each variant.

To determine the green mass production and chemical analyses, 1 sqm was harvested from each repetition plot and the remaining 17 sqm was effectively grazed with dairy cows, so the results are much closer to the conditions in production, compared to imitation by mowing.

The study took into account the last 5 years 2019-2023, which represents the average of the 24-28 years since the radical restoration of the grasslands.

The productivity of the grasslands was evaluated according to the new method based on floristic survey (MARUȘCA 2019).

The evaluation of the production of green fodder mass serves to establish the optimal animal load for each improvement technology in particular.

The pastoral value index multiplied by the conversion coefficient in milk production which is 51.24 determined after 25 years of actual experience with cows next to the experience we are analyzing (MARUȘCA et al. 2018).

In the fall of 2023, 28 years after the application of amendments and processing the upper layer of the soil, average soil samples were taken at a depth of 0-15 cm, a control from the path between the repetitions and from all 18 improvement variants. The analyses were performed according to the standardization method at OSPA Brașov.

RESULTS AND DISCUSSIONS

Due to a very large volume of data obtained 28 years after the application of calcium amendment, overseeding and reseeded, 3 distinct works were published depending on the fertilization system used, namely: mineral (MARUŞCA, 2024 a), organo-mineral (MARUŞCA, 2024 b) and organic (2023). The results regarding the production of green

fodder mass, pastoral value and milk production were evaluated based on floristic survey and feed-milk conversion indices (MARUŞCA, 2019; MARUŞCA et al. 2018). In a first phase, a comparative analysis of the agrochemical characteristics of the soil is made 28 years after the establishment of the experiment (Table 1).

Table 1

Agrochemical values of soil depending on improvement technology Blana Bucegi 2023

Specification	pH (H ₂ O)	V _{Ah} (%)	Humus (%)	IN	Mobile phosphor* ppm	Mobile potassium ppm	Exchangeable aluminium me/100g soil
Wt. 000	4.6	17.5	11.59	2.03	15	190	4.12
111	4.5	21.8	12.26	2.67	29	176	4.52
121	4.5	20.3	12.26	2.49	23	180	4.70
131	4.6	21.8	12.14	2.65	29	196	4.40
Average 101	4.5	21.3	12.22	2.60	27	184	4.54
112	4.9	35.3	12.20	4.31	26	166	1.82
122	5.1	46.7	12.32	5.75	27	160	0.84
132	5.0	38.9	12.32	4.79	23	168	1.38
Average 102	5.0	40.3	12.28	4.95	25	165	1.35
Average 110	4.7	28.6	12.23	3.49	28	171	3.17
Average 120	4.8	33.5	12.29	4.12	25	170	2.77
Average 130	4.8	30.4	12.23	3.72	26	182	2.89
211	4.8	30.7	12.20	3.75	29	224	2.64
221	4.7	28.3	12.32	3.49	16	180	3.06
231	4.7	27.2	12.32	3.35	19	186	3.10
Average 201	4.7	28.7	12.28	3.53	21	197	2.93
212	5.0	40.8	12.26	5.00	21	206	1.26
222	5.0	40.6	12.26	4.98	20	186	1.41
232	5.0	36.4	12.32	4.48	15	156	1.74
Average 202	5.0	39.3	12.28	4.82	19	183	1.47
Average 210	4.9	35.8	12.23	4.38	25	215	1.95
Average 220	4.9	34.5	12.29	4.24	18	183	2.24
Average 230	4.9	31.8	12.32	3.92	17	171	2.42
311	4.6	24.7	12.26	3.03	19	188	3.80
321	4.8	32.9	12.32	4.05	18	186	3.34
331	4.8	24.5	12.26	3.00	14	176	4.90

Specification	pH (H ₂ O)	V _{Ah} (%)	Humus (%)	IN	Mobile phosphor* ppm	Mobile potassium ppm	Exchangeable aluminium me/100g soil
Average 301	4.7	27.4	12.28	3.36	17	183	4.01
312	5.1	41.1	12.26	5.04	19	180	0.92
322	5.0	39.1	12.32	4.82	16	142	1.62
332	5.1	33.0	12.32	4.07	10	158	2.44
Average 302	5.1	37.7	12.30	4.64	15	160	1.66
Average 310	4.9	32.9	12.26	4.04	19	184	2.36
Average 320	4.9	36.0	12.32	4.44	17	164	2.48
Average 330	5.0	28.8	12.29	3.54	12	167	3.67

From these data it can be seen that the soil reaction in variants 101 (mineral fertilization, on unamended soil) has a pH of 4.5, 0.1 index lower than the control variant (000), indicating soil acidification.

The calcium-amended variants (102) have an average pH index of 5.0, respectively 0.5 higher than the unamended variants.

Variants 201 (organo-mineral fertilization on unamended soil) have a pH index of 4.7, 0.2 higher than variants 101 due to organic fertilization, continued after a first stage of mineral fertilization.

Variants 202 (amended) are identical to variants 102, both having a pH index of 5.0.

In variants 301 (organic fertilization on unamended soil) the average pH values are similar to variants 201.

In contrast, variants 302 (organic, amended) have the highest pH values, namely 5.1, 0.1 higher than in variants 102 and 202.

The degree of base saturation (V_{Ah}, %) is closely related to the soil reaction (pH).

The lowest value of 21.3% V_{Ah} was in variant 101 and the highest of 40.3 in variants 102.

The humus content was little influenced by the fertilization and amendment system, with values of 12.2-12.3% average content after 28 years.

The lowest nitrogen (N) index of 2.6 was calculated for variants 101 and the highest of 4.95 for variants 102. In general, the calcium-amended variants have a much higher N index than the unamended variants.

The other average values of mobile phosphorus (P) content ranging between 15-27 ppm and mobile potassium (K) ranging between 160-197 ppm, are extremely heterogeneous, due to the different consumption of plants in the meadows.

There are large differences in the exchangeable aluminum content with variations from 1.35 me/100 g soil for the amended variants 102 to 4.54 me/100 g soil for the unamended variants 101,

which exceed by 0.42 me/100 g soil, the control variant (000).

Regarding the influence of the type of grass cover on the agrochemical characteristics of the soil on amended and unamended soil, no significant differences were

found. Finally, a general analysis of the influence of the fertilization system, the type of grass cover and calcium amendment on the agrochemical characteristics of the soil was made (Table 2).

Table 2

Influence of technological factors on agrochemical characteristics after 28 years (1995-2023)

Specification	pH (H ₂ O)	V _{Ah} (%)	Humus (%)	IN	Mobile phosphor* ppm	Mobile potassium ppm	Exchangeable aluminium me/100g soil
Wt	000	4.6	17.5	11.59	2.03	15	190
A	100	4.8	30.8	12.25	3.78	26	174
	200	4.9	34.0	12.28	4.18	20	190
	300	4.9	32.6	12.29	4.00	16	172
	Difference(%)						
	100-000	104	176	106	186	174	92
	200-000	106	194	106	206	133	100
	200-100	102	110	100	110	76	109
	300-000	107	186	106	197	107	90
	300-100	103	106	100	106	61	98
	300-200	100	96	100	96	80	90
B	010	4.8	32.4	12.24	3.97	24	190
	020	4.9	34.7	12.30	4.26	20	172
	030	4.9	30.3	12.28	3.72	18	173
	Difference(%)						
	010-000	105	185	106	195	159	100
	020-000	105	198	106	210	133	91
	020-010	101	107	100	107	133	91
	030-000	106	173	106	183	122	91
	030-010	101	93	100	94	77	91
	030-020	101	87	100	87	92	101
C	001	4.6	25.0	12.25	3.07	24	191
	002	5	39.8	12.28	4.89	22	174
	Difference(%)						
	001-000	100	143	107	101	160	100
	002-000	109	227	106	241	148	91
	002-001	108	159	100	159	92	91

Note:

A: fertilization, 100 (mineral), 200 (organo-mineral), 300 (organic);

B: grassy carpet, 010 (natural), 020 (overseeded), 030 (reseeded);

C: calcium amendment, 001 (unamended), 002 (amended).

Thus, on average, the A factor (fertilization) variants 200 (organo-mineral) proved superior to 100 and 300, for most agrochemical characteristics.

The B factor (grass carpet type) the most valuable proved to be the 020 (overseeding) variants followed by 010 (natural) and 030 (reseeding).

This result confirms the superiority of the superficial intervention on the degraded grass carpet top soil also found in other older experiences on *Nardus stricta* grasslands from Vlădeni, Brașov County, where overseeding after total herbicide application with "Gramoxone" gave the best results. (MARUȘCA, 1977).

The strongest effect on the agrochemical characteristics of the soil was the calcium amendment in all fertilization systems (100, 200, 3000 and types of grass carpet (010, 020, 030) explained in detail in the first part of the results of this long-term experience.

The agrochemical characteristics of the soil modified by the grassland improvement factors have a direct influence on the floristic composition (Table 3, part I and II).

Thus, on average, in the years 2019-2023, mineral fertilization (100) favored more the species of the spontaneous flora *Agrostis capillaris* 25.2%, *Festuca nigrescens* 10.7%, *Poa media* 6.5%, *Agrostis rupestris* 6%, *Festuca*

ovina 5.5% and the maintenance of the species *Nardus stricta* 4.6%.

Mineral fertilization followed by organic fertilization stimulated the species *Poa pratensis* 26.5%, *Trifolium repens* 38.5% and *Taraxacum officinale* 4% and the exclusively organic one by night paddocking (300) stimulated in a lower proportion the same species as variant 200, to which is added *Polygonum bistorta* 0.4% absent in variants 100 and 200.

The former dominant species *Nardus stricta* was completely removed from the grassy carpet of variants 200 and 300.

Regarding the type of grassy carpet, it is found that in the natural one (010) *Poa pratensis* 35.1%, *Trifolium repens* 16.1%, *Festuca nigrescens* 12.1%, *Ligusticum mutellina* 5.9%, *Taraxacum officinale* 3.5%, *Deschampsia flexuosa* 3.3% and *Campanula serrata* 2.1% are maintained in a higher proportion.

By total herbicide application and overseeding (020) the specie *Phleum pratense* was stimulated 15.3% and by reseeding (030) the species *Agrostis capillaris* 34%, *Agrostis rupestris* 5.5% and *Poa media* 4.6%.

In the variants without amendment (001) the following species are in higher proportion: *Agrostis capillaris* 23.6%, *Festuca nigrescens* 11.7%, *Poa media* 6.9%, *Agrostis rupestris* 4.4%, *Deschampsia flexuosa* 4%, *Potentilla ternata* 3%, *Nardus*

stricta 2.8%, *Deschampsia* and *Anthoxanthum odoratum* 0.7%.
caespitosa 1%

Table 3

The influence of technological improvement factors on floristic composition (part I)

No.	Species	Indices		A. Fertilisation			
		F	M	Average (%)			
				100	200	300	X00
G	Gramineae	x	x	77.5	69.1	68.0	71.5
1	<i>Agrostis capillaris</i>	7	5	25.2	16.8	21.3	21.1
2	<i>Agrostis rupestris</i>	5	1	6.0	1.6	3.1	3.5
3	<i>Anthoxanthum odoratum</i>	5	3	1.0	0.2	0	0.4
4	<i>Deschampsia caespitosa</i>	3	0	1.2	1.0	0.4	0.8
5	<i>Deschampsia flexuosa</i>	4	3	5.5	0.5	0.4	2.1
6	<i>Festuca ovina ovina</i>	5	4	0.5	0	0	0.2
7	<i>Festuca nigrescens</i>	7	5	10.7	8.8	9.5	9.7
8	<i>Nardus stricta</i>	3	0	4.6	0	0	1.5
9	<i>Poa annua</i>	7	2	0	0.2	0	0.1
10	<i>Poa media</i>	5	2	6.5	3.8	2.5	4.2
11	<i>Poa pratensis</i>	8	6	9.5	26.5	20.0	18.7
12	<i>Phleum alpinum</i>	7	2	1.6	0.3	0.7	0.8
13	<i>Phleum pratensis</i>	9	8	5.5	9.8	10.1	8.5
L	Leguminosae	x	x	6.3	19.3	20.8	15.4
14	<i>Trifolium repens</i>	8	5	6.3	38.5	20.8	21.9
AF	Other families	x	x	16.2	11.6	11.2	13.1
15	<i>Campanula abietina</i>	3	0	0.2	0.9	0.5	0.5
16	<i>Campanula serrata</i>	3	0	1.9	1.6	0.6	1.4
17	<i>Geum montanum</i>	4	1	1.2	0.9	0	0.7
18	<i>Hieracium aurantiacum</i>	4	2	0.8	0.9	0.5	0.7
19	<i>Linguisticum mutellina</i>	7	1	5.2	0.9	2.0	2.7
20	<i>Polygonum bistorta</i>	5	4	0	0	0.4	0.1
21	<i>Potentilla ternata</i>	4	1	4.6	0.7	0.9	2.0
22	<i>Rumex acetosella</i>	3	0	0.2	0.3	0.1	0.2
23	<i>Taraxacum officinalis</i>	7	3	0.3	4.0	3.9	2.7
24	<i>Viola declinata</i>	3	0	0.8	0.1	0.3	0.4
25	Alte specii	3	0	1.1	1.5	2.3	1.7
PV	Pastoral value (ind.)			69.2	80.7	79.2	76.3
GM	Green mass production (t/ha)			9.16	13.40	13.15	11.90

By calcium amendment (002), the species *Poa pratensis* 23.9%, *Trifolium repens* 20.2%, *Phleum pratense* 11.2% and

Taraxacum officinale 3.1% are particularly stimulated, the species *Nardus stricta* being eliminated from the grassy carpet.

Table 3

The influence of technological improvement factors on floristic composition (part II)

No.	A. Fertilisation			B. Grass carpet						C. Amendment		
	Difference (%)			Average (%)			Difference (%)			Average (%)		Dif. (%)
	200 100	300 100	300 200	010	020	030	020 010	030 010	030 020	001	002	002 001
G	89	88	98	65.8	73.3	75.5	111	115	103	75.8	67.2	89
1	67	85	127	4.3	25.1	34.0	578	784	136	23.6	18.6	79
2	27	52	196	0.9	4.3	5.5	474	611	129	4.4	2.7	62
3	16	0	0	0.7	0.1	0.3	14	43	300	0.7	0.1	10
4	83	30	37	0.7	0.5	1.2	68	168	247	1.0	0.7	69
5	8	7	89	3.3	1.4	1.7	44	51	116	4.0	0.2	6
6	0	0	0	0.4	0.1	0	27	9	33	0.3	0	11
7	82	88	107	12.1	8.1	8.8	67	73	109	11.7	7.6	64
8	0	0	0	2.4	0.7	1.5	30	63	214	2.8	0.2	8
9	0	0	0	0.2	0	0	0	0	0	0.1	0	0
10	58	39	67	4.0	4.2	4.6	103	114	110	6.9	1.5	22
11	280	212	75	35.1	13.2	7.7	38	22	58	13.4	23.9	178
12	16	42	260	1.5	0.2	0.6	13	40	300	1.2	0.5	40
13	178	183	103	0.4	15.3	9.6	3833	2408	63	5.7	11.2	198
L	308	333	108	16.1	15.6	14.5	97	90	93	10.6	20.2	190
14	616	333	54	16.1	15.6	14.5	97	90	93	10.6	20.2	190
AF	72	69	97	18.1	11.1	9.8	61	54	88	13.6	12.5	92
15	600	300	50	0.4	0.5	0.8	108	192	179	0.6	0.4	58
16	84	32	38	2.1	1.1	1.3	52	63	122	1.3	1.5	116
17	71	0	0	0.8	0.2	0.9	25	117	467	0.5	0.9	173
18	106	63	59	0.3	0.5	1.3	150	390	260	1.0	0.5	48
19	16	38	229	5.9	1.5	0.5	26	8	30	2.7	2.6	95
20	0	0	0	0	0.1	0.3	0	0	400	0.1	0.1	100
21	14	19	131	1.9	0.8	1.4	40	71	178	3.0	1.0	33
22	150	25	17	0.3	0.2	0	50	10	20	0.3	0.1	38
23	1333	1300	98	3.5	2.7	2.1	76	60	79	2.3	3.1	134
24	13	38	300	0.3	0.2	0.6	78	211	271	0.4	0.4	100
25	136	209	153	2.7	1.3	0.8	49	31	63	1.3	2.1	158
PV	117	114	98	75.8	78.4	75.0	103	99	96	72.3	80.4	111
GM	146	144	98	10.97	12.85	11.79	117	107	92	10.5	13.30	127

Next, after the influence of improvement factors on floristic composition, their influence on

green fodder production is presented (Table 4).

Table 4

The influence of technological improvement factors on green fodder production and grazing capacity

Factor	Variant	Average production (t/ha)	Optimal animal loading (LU/ha)	%
A Fertilisation	100	9.16	1.66	100
	200	13.40	2.43	146
	300	13.15	2.38	144
B Grass carpet	010	10.97	1.99	100
	020	12.85	2.33	117
	030	11.79	2.13	107
C Amendment	001	10.50	1.90	100
	002	13.30	2.41	127

From these data it results that the greatest influence on production has the organo-mineral fertilization (200) with 46% followed by calcium amendment (002) with 27% and overseeding with 17% compared to variants 100, 010 and 001 taken as a control.

The production of green mass is between 9.16 to 13.4 t/ha in variants 100 and 200, which allow a loading with 1.66 to 2.43 UVM/ha.

The same variants (200, 020 and 002) also have the highest pastoral value and milk production (Table 5).

Table 5

Influence of technological improvement factors on pastoral value and milk production in 85 days of grazing season

Factor	Variant	Pastoral value (ind)	Milk production (l/ha)	%
A Fertilisation	100	69.2	3.545	100
	200	80.7	4.135	117
	300	79.2	4.058	114
B Grass carpet	010	75.8	3.880	100
	020	78.4	4.020	103
	030	75.0	3.840	99
C Amendment	001	72.3	3.704	100
	002	80.4	4.120	111

At the pastoral value of 69.02 (good) to 80.7 (very good) 3545 liters of milk per hectare to 4135 l/ha were evaluated in 85 days of optimal grazing season in transhumance at 1800 m altitude.

The highest effect on milk production was had by organo-

mineral fertilization with 17%, amendment with 11% and reseeding with 3%, compared to controls, similar to green mass production.

From this point of view, less milk per hectare was evaluated on the reseeded variants than on the grassland with natural grass carpet,

which indicates the maximum duration of a reseeded grassland of up to 25 years in the subalpine level.

Finally, based on published data (MARUȘCA, 2023, 2024 a,b) separately for the mineral (100),

organo-mineral (200) and organic (300) fertilized variants, the weakest and best improvement variants with their productivity are presented (Table 6).

Table 6

Comparative situation between the worst and the best three options for improving the *Nardus stricta* grasslands

Variant A - fertilisation B – grass carpet C - amendment	Green mass production (t/ha)	Pastoral value (ind.)	Milk production (L/ha)
I Low variants			
111 mineral, natural, unamended	5.45	59.5	3050
131 mineral, reseeded, unamended	6.71	60.4	3095
121 mineral, overseeded, unamended	7.42	62.7	3215
Average I (low variants)	6.53	60.9	3120
II Good variants			
222 organo-mineral, overseeded, amended	15.02	84.8	4345
212 organo-mineral, natural, amended	14.31	82.1	4205
322 organic, overseeded, amended	14.36	82.0	4200
Average II (good variants)	14.56	83.0	4250
Difference II-I	+, -	+ 8.03	+ 22.1
	%	222	136

The variants with the lowest pastoral values (PV), green mass production (GM) and milk (L) assessed as weak were in order 111,131 and 121 mineral fertilized (NPK) on unamended soil on all types of grassy carpet, which was evaluated on average 6.53 t/ha MV; 60.9 VP and 3120 L/ha.

The variants with the highest PV, GM and milk production which are the best recommended ones, were 222, 212 and 322, amended with calcium, organically fertilized (night paddocking) or organo-mineral, overseeded and natural,

where 14.56 t/ha GM was evaluated with 222% more than in the weak variants; 83 PV and 4250 L/ha, with 136 higher than the first 3 weaker variants.

These data are very close to the results obtained in a parallel experience with dairy cows where on the amended version, natural grassy carpet fertilized initially mineral (NPK) and then organically (sowing), an average of 4070 liters of milk per hectare was obtained over 25 years in a grazing season of 85 days (MARUȘCA et al. 2022).

CONCLUSIONS

Subalpine grasslands dominated by *Nardus stricta* located on strongly acidic soils can be improved by various methods in long-term experiences with very good results.

The best improvement options are calcium amendment to correct soil acidity with an effect of over 30 years, total herbicide application with glyphosate and overseeding, fertilization with mineral fertilizers (NPK) for 3

consecutive years, followed by organic fertilization (soil fertilization) with sheep or cattle once every 6 years.

The evaluation of green mass production and the pastoral value index based on floristic survey, followed by the application of the feed-milk transformation coefficient are sufficiently accurate to establish the best options for improving permanent grasslands.

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