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Study regarding the influence of some technological inputs on soil-plant-animal interrelation in the frame of *Festuca rubra* ecosystem of pasture from boreal level (Cindrel Mountains)

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Abstract. In this paper the results of research regarding the influence of technological inputs on the quality of a *Festuca rubra* mountain pasture are presented. Organic fertilization (sheep folding), moderate fertilization with chemical fertilizers ($N_{100}P_{22}K_{83}$ kg·ha^{-1}·y^{-1}) and completion of the latter with over sowing (*Trifolium repens*) determine favorable changes in floristic composition of sward canopy. These changes are the results of improvement of nutritional status of plants with fodder value in macro elements (as nitrogen and phosphorus) and they have as effect both the increase of dry matter (DM) yield and the improvement of it's quality, aspect indicated by growing of consumption efficiency by sheep.
Key Words: *Festuca rubra*, sward canopy, nutritional indexes, consumption efficiency.

Rezumat. În această lucrare sunt prezentate rezultatele cercetării privind influenţa unor inputuri tehnologice asupra calităţii unei pajişti montane de *F. rubra*. Fertilizarea organică (târlit), fertilizarea moderată cu îngrăşăminte chimice ($N_{100}P_{22}K_{83}$ kg·ha^{-1}·an^{-1}) şi asocierea acesteia din urmă cu supraînsămânţarea (*Trifolium repens*) determină modificări favorabile în compoziţia floristică a covorului vegetal. Aceste modificări sunt rezultatul îmbunătăţirii stării de nutriţie cu macroelelmente (precum N şi P) a plantelor cu valoare furajeră şi au ca efect atât creşterea recoltei de substanţă uscată (SU), cât şi îmbunătăţirea calităţii acesteia, aspect indicat de creşterea eficienţei consumului de către ovine.
Cuvinte cheie: *Festuca rubra*, covor vegetal, indici de nutriţie, eficienţa consumului.

Introduction. Utilization of pastures for grazing could be one of the most simple and most efficient ways of animals' feeding. The primary objectives of grassland management under grazing are to supply high quality forage for as long as possible trough the season, and to ensure efficient utilization by the grazing animal while maintaining acceptable levels of animal performance (Mayne et al 2000). Pasture vegetation represents a sensible index both of environmental conditions and of man and his animals' actions. Cindrel Mountains area (Meridional Carpathians, Romania) with its specific ecological conditions, unfavorable to the majority of agricultural crops, contributed at the development of a local tradition in sheep growing. This fact determined the farmers and the research workers to focus their attention on mountain pastures. *Festuca rubra* mountain pastures - R 3803 habitat, correspondent of Nature 2000-6510 (Doniţă et al 2005) - from Cindrel Mountains are natural secondary pastures which present an interesting production potential for animal breeders. The studies, which of results are presented further, have been done in order to complete the scientific information regarding the utilization of this type of pasture for grazing.

Material and Method. The research was developed during the years 2002 and 2003, on a *Festuca rubra* mountain pasture (R 3803 habitat; Nature 2000-6510) on a Dystric cambisol type of soil, from Cindrel Mountains, at 1348 m a.s.l. (boreal level). The boreal climate in this region is characterized by annual mean temperature of 4.5°C and annual rainfall over 900 mm. The experiment included four blocks with cutting usage and one block with grazing usage. In this paper are presented the results obtained in block with grazing usage, which included the following treatments: 1) *Festuca rubra – Agrostis capillaris* pasture as control; 2) $N_{100}P_{22}K_{83}$ kg·ha^{-1}·y^{-1}; 3) sheep folding during 3 nights (one sheep m^{-2}); 4) $P_{22}K_{83}$ kg·ha^{-1}·y^{-1}+ over sowing with *Trifolium repens*; 5) $P_{22}K_{83}$ kg·ha^{-1}·y^{-1}. The fertilizations were applied in each spring in the beginning of vegetation. The botanical composition was determined by Braun-Blanquet method (presented by Rotar et al 2005) and the identified species were divided in four economic groups from fodder point of view (grasses, legumes, sedges-rush family plants and other botanical families). The yield and the efficiency of consumption were determined by cutting and weighing of harvest obtained during vegetative period. The nutritional indexes of plants for nitrogen (INN) and phosphorus (INP), were determined by next relations: $(INN)=100 \cdot N/4.8 \cdot DM^{-0.32}$; $(INP)=100 \cdot P/(0.15+0.065 \cdot N)$, elaborated by Lemaire (1997) and Balent et al (1997). Grazing was done with ovine youth of Turcana breed.

Results and Discussion. Based on botanical composition, 27 species which belong to 14 botanical families were identified (Table 1). Among those 14 families, 12 belong to Class *Dicotyledonae* and 2 to Class *Monocotyledonae* (Ciocârlan 2000). Monocotyledonous species from *Poaceae* family had the highest gravity in the sward canopy.

Table 1

List of species of plants identified in five studied variants

Crt. no.	*Families*	*Species*
1.	*Poaceae*	*Agrostis capillaris* L.
2.		*Anthoxanthum odoratum* L.
3.		*Cynosurus cristatus* L.
4.		*Dactylis glomerata* L.
5.		*Festuca rubra* var. commutata Gaudin.
6.		*Phleum pratense* L.
7.		*Poa pratensis* L.
8.	*Fabaceae*	*Lotus corniculatus* L.
9.		*Trifolium repens* L.
10.		*Trifolium pratense* L.
11.	*Apiaceae*	*Daucus carota* L.
12.	*Asteraceae*	*Achillea millefolium* L.
13.		*Leontodon autumnalis* L.
14.		*Taraxacum officinale* Weber ex Wiggers
15.	*Boraginaceae*	*Myosotis arvensis* Hill.
16.	*Campanulaceae*	*Campanula abietina* Griseb.
17.		*Stellaria graminea* L.
18.	*Hypericaceae*	*Hypericum maculatum* Crantz.
19.	*Liliaceae*	*Veratrum album* L.
20.	*Plantaginaceae*	*Plantago lanceolata* L.
21.	*Polygonaceae*	*Rumex acetosella* L.
22.	*Ranunculaceae*	*Ranunculus polyanthemos* L.
23.	*Rosaceae*	*Alchemilla vulgaris* L.
24.		*Fragaria vesca* L.
25.	*Schrophulariaceae*	*Rhinanthus glaber* Lam.
26.		*Veronica chamaedris* L.
27.	*Violaceae*	*Viola declinata* Waldst et kit.

As it can be observed from data of Table 2, the application of inputs determined a high degree of land covering with vegetation (90%-95%).

Grasses had the highest gravity and formed a compact sward canopy, dominated by *F. rubra* which presents medium abundance dominance (ADm) of 52.5%. The most constant species (K-V) were *F. rubra, A. capillaris, T. repens* and *T. pratense*.

Among the other recorded species, more significant changes of their gravity than in natural pasture were remarked at *A. capillaris, P. pratensis* and *Ph. pratense*. These species have fodder value medium and good (F=3, 4, 5 by Kovacs 1979). In case of variant fertilized with $N_{100}P_{22}K_{83}$ kg·ha^{-1}·y^{-1}, *A. capillaris* recorded almost the same gravity as *F. rubra*. Organic fertilization favored the increase of *P. pratensis* gravity (10%) in the sward canopy. Mineral fertilization stimulated the extension of *Ph. pratense* gravity in the sward canopy of variants 2, 3 and 5. Legumes, especially *T. repens*, were stimulated by mineral fertilization. In the variant organic fertilized, in contrast with the other variants, the presence of *L. corniculatus* was observed.

Among the species which appertain to the other botanical families, with a higher representation in the sward canopy (5% gravity), *A. millefolium, A. vulgaris, T. officinale* and *S. graminea* were remarked. In the mineral fertilized variants the presence of a semi parasitic and harmful weed (*R. glaber*) was found.

Table 2

Floristic composition in second year of experiment, at first cycle of harvesting

Variant		V_1	V_2	V_3	V_4	V_5	*K*	*ADm*
Altitude (m)				1348				
Geographical exhibition				S				
Slope inclination (°)				5				
Surface (m^2)				72				
General coverage (%)		85	95	90	95	90		
Fodder value (F)	POACEAE							
3	*A. capillaris*	1	3	2	1	1	V	14.0
1	*A. odoratum*	+	+	+	+	-	IV	0.4
3	*C. cristatus*	+	+	+	+	-	IV	0.4
5	*D. glomerata*	-	+	+	+	-	III	0.3
2	*F. rubra*	4	3	3	4	4	V	52.5
5	*Ph. pratense*	+	1	-	1	1	IV	3.1
4	*P. pratensis*	+	1	2	1	-	IV	7
	FABACEAE							
4	*L. corniculatus*	-	-	+	-	-	I	0.1
4	*T. pratense*	+	+	+	+	+	V	0.5
4	*T. repens*	+	1	+	1	1	V	3.2
	OTHERS BOTANICAL FAMILIES							
2	*A. millefolium*	-	+	1	+	1	IV	2.2
2	*A. vulgaris*	1	+	+	1	-	IV	2.2
X	*C. abietina*	+	-	+	+	-	III	0.5
2	*D. carota*	-	-	-	-	+	I	0.1
1	*F. vesca*	+	-	+	-	-	II	0.1
-	*H. maculatum*	+	-	-	-	-	I	0.2
1	*L. autumnalis*	+	-	+	+	-	III	0.2
X	*M. arvensis*	-	-	-	+	-	I	0.2
2	*P. lanceolata*	-	-	+	+	-	II	0.2
X	*R. polyanthemos*	+	-	-	+	+	III	0.5
X	*R. acetosella*	-	-	+	+	+	III	0.5
-	*R. glaber*	-	+	-	+	+	III	0.5
X	*S. graminea*	+	+	+	-	1	IV	0.5
2	*T. officinale*	1	+	+	+	-	IV	2.3
X	*V. chamaedris*	+	+	-	+	-	III	0.3
-	*V. album*	+	-	+	-	-	II	0.2
-	*V. declinata*	+	-	+	+	-	III	0.3

The values of nutritional indexes of plants for nitrogen at first cycle of harvesting (Table 3) show a good nutritional status of plants just in the variant fertilized with $N_{100}P_{22}K_{83}$ $kg \cdot ha^{-1} \cdot y^{-1}$. In the other variants plants had a poor nutrition with nitrogen (values smaller than 80). In the second cycle of harvesting a poor nutrition with nitrogen was recorded for all the variants. The poor nutrition with N of plants of the mentioned variants reverberates in the level of dry matter yields obtained for these variants (Tables 4 and 5).

Table 3

Nutritional status of plants with N and P in the *Festuca rubra* pasture

First cycle of harvesting		*Variants*	*Second cycle of harvesting*	
INN	INP		INP	INN
54.96	69.83	Natural pasture	70.42	40.70
93.84	77.12	$N_{100}P_{22}K_{83}$ $kg \cdot ha^{-1} \cdot y^{-1}$	90.35	59.56
59.53	64.25	Sheep folding (one sheep$\cdot m^{-2}$ – 3 nights)	96.42	46.35
55.24	114.29	$P_{22}K_{83}$ $kg \cdot ha^{-1} \cdot y^{-1}$ + over sowing with *Trifolium repens*	89.49	55.09
65.45	89.23	$P_{22}K_{83}$ $kg \cdot ha^{-1} \cdot y^{-1}$	75.32	54.56

Calculated values of nutritional index with P show a normal nutrition of plants in this element (values over 80) just in case of both variants fertilized with $P_{22}K_{83}$ $kg \cdot ha^{-1} \cdot y^{-1}$ for the first cycle of harvesting. A nutritional status near by normal also present the plants of variant fertilized with $N_{100}P_{22}K_{83}$ $kg \cdot ha^{-1} \cdot y^{-1}$. In the second cycle of harvesting a normal nutritional status with P present the plants from V2, V3 and V4 variants. In both cycles of harvesting just for variant fertilized with $P_{22}K_{83}$ $kg \cdot ha^{-1} \cdot y^{-1}$ and over sowed with *Trifolium repens* a normal nutritional status with P of plants was maintained. The positive reaction of vegetation at all applied inputs was evident both on floristic composition, stimulating the species with good fodder value (Table 2), and on dry matter yield, obtaining high forage yields (Table 4). Thus, at the first cycle of harvesting, yields higher with 25-82% than in natural pasture were obtained. Nutritional status of plant, normal for N respectively almost normal for P, in the variant fertilized with $N_{100}P_{22}K_{83}$ $kg \cdot ha^{-1} \cdot y^{-1}$, considerably influenced the level of forage yield obtained. Thus, yield efficiency obtained in this variant was the highest (1.31 $t \cdot ha^{-1}$). Fertilization with $P_{22}K_{83}$ $kg \cdot ha^{-1} \cdot y^{-1}$ determined lower yield efficiencies, fact which demonstrates the lower influence of separate fertilization with P and K in comparison with complex fertilization with N/P/K. The situation of plant nutrition in variant 4 reflects very well the low of irreplaceableness of vegetation factors and their equal importance (Rusu et al 2005). Thus, fertilization with $P_{22}K_{83}$ $kg \cdot ha^{-1} \cdot y^{-1}$ determined a nutritional status of plant with P near by luxury nutrition (120 – value which indicates luxury nutrition of plants), as it can be observed from table 3 data, while plant nutrition with N was serious poor.

Table 4

Dry matter yield at first cycle of harvesting

Experimental variants	*DM yield (t/ha)*	*Relative yield (%)*	*Differences (+/-)*
V_1	1.60	100.00	0.00
V_2	2.91	182.00	1.31
V_3	2.02	126.00	0.42
V_4	2.40	150.00	0.80
V_5	2.00	125.00	0.40

The levels of yields obtained for second cycle of harvesting in all variants were lower in comparison with those obtained for first cycle of harvesting (Tables 4 and 5). Nevertheless, the influence of applied inputs reverberated on forage harvest through values of relative yields obtained in this cycle, values which were higher than those obtained in first cycle. Yield efficiencies obtained in second cycle of harvesting doesn't outrun for none of variant 1 t DM ha^{-1}. The low values of yields own both to poor nutrition with N of plants from all variants and to the modification at this cycle of ratio between stems and leaves, in the latter ones favor. The synergic effect of application at the same time of N/P/K fertilizers (V2) is emphasized both by the values of nutritional indexes of plants for N and P and by the highest level of DM yield obtained in case of this variant.

Interrelation soil-plant-animal is evidently in case of pastures usage by grazing (Table 6). The plant-animal interface represents the dynamic interchange between the herbivore and the ecosystem (Barnes et al 2007). Thus, the presence of *A. capillaris, P. pratensis*, *Ph. pratense, T. pratense, T. repens* and *L. corniculatus* species, with higher fodder value than *F. rubra*, favorably influenced the forage consumption (Table 6). The increase of these species gravity in sward canopy was the result of influence of the applied inputs, which contributed at the increase of the soil content in macro element, necessary and available at plants.

Table 5

DM yield at the second cycle of harvesting

Experimental variants	*DM yield (t/ha)*	*Relative yield (%)*	*Differences (+/-)*
V_1	0.7	100.00	0.00
V_2	1.6	228.57	0.90
V_3	1.1	157.14	0.40
V_4	1.39	198.57	0.69
V_5	1.35	192.85	0.65

Forage consumption (DM) in case of both cycles of grazing was higher in case of all fertilized variants than in the natural pasture. Among the fertilized variants, in those with mineral fertilization, higher forage consumption was recorded. Analyzing the consumption efficiency for each variant partly (Ce/v) as well as the consumption efficiency referred at natural pasture production (Ce/np), at the second cycle of grazing, net superior relative values in comparison with first cycle were recorded. One of the explanations is given by harvesting phenophase at first cycle, when prevailing were the generative shoots, respectively by the ratio leaves/stems. This explanation coincides with the results obtained by Vignau-Loustau et al (2008). Vegetative shoots, more rich in leaves, which determine higher consumption and higher quality of forage, dominated in the second cycle of grazing. The quality of the various plant tissues tends to follow the next order: legume leaf>forb leaf>grass leaf>legume stem>grass stem>shrub leaf>forb stem>shrub stem (Barnes et al 2007).

Table 6

The influence of technological inputs on forage consumption of ovine

First cycle of grazing			*Variant*	*Second cycle of grazing*		
Consumed DM quantity (t/ha)	Consumption efficiency (Ce/v) (%)	Consumption efficiency (Ce/np) (%)		Consumed DM quantity (t/ha)	Consumption efficiency (Ce/v) (%)	Consumption efficiency (Ce/np) (%)
1.15	71.80	100	V1	0.50	71.40	100
2.14	73.50	186	V2	1.30	81.00	260
1.44	71.20	125	V3	0.80	72.70	160
1.91	79.50	166	V4	1.18	84.80	236
1.55	77.50	138	V5	1.17	96.60	234

Conclusions. Application of inputs assured the development of a compact sward canopy. In case of variant fertilized with $N_{100}P_{22}K_{83}$ kg·ha^{-1}·y^{-1}, in the second experimental year, *A. capillaris* reached almost the same gravity as *F. rubra*. Organic fertilization favored the increase of *P. pratensis* gravity in the sward canopy (10%). Legumes, especially *T. repens,* are stimulated by mineral fertilization. In the first cycle of harvesting, plants had a proper nutritional status with N just in the variant fertilized with $N_{100}P_{22}K_{83}$ kg·ha^{-1}·y^{-1}. In the second cycle of harvesting, a poor nutrition with N was recorded for all variants. For both cycles just in the variant fertilized with $P_{22}K_{83}$ kg·ha^{-1}·y^{-1} and over sowed with *T. repens* a normal nutritional status with P remained. The nutritional status of plants in the variant fertilized with $N_{100}P_{22}K_{83}$ kg·ha^{-1}·y^{-1} considerably influenced the level of forage yield, the yield efficiency recorded for this variant being the highest (1.31 t·ha^{-1}). Fertilization with $P_{22}K_{83}$ kg·ha^{-1}·y^{-1} determined lower yield efficiencies, which demonstrates the lower influence on yield of separate fertilization with P/K than complex fertilization with N/P/K. The influence of utilized inputs reverberated on forage yield through the high values of relative yields obtained for the second cycle in comparison with those obtained for the first cycle. Forage consumption (DM) for both cycle of grazing was higher in all fertilized variants than in natural pasture and among these remarked mineral fertilized variants. For the second cycle of grazing the consumption efficiency was higher than for the first cycle.

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