Summary

Natural grasslands at SCDA Turda and the response to changing trophicity of *Festuca rupicola*

PhD student **Ioan GAGA**

Scientific coordinator **Prof. univ. dr. Ioan Rotar**

Introduction

In Romania, there is a wide variety of types of grasslands (DONIȚĂ et al. 1992, SANDA et al. 2008), and their appearance is mainly determined by geographical position, geomorphology, soil type and land use. In some regions, for example in the Transylvanian Plain (central Romania), there are still extensive dry grasslands that are remarkable in diversity and state of conservation compared to European standards. This region still harbors large areas of high nature value grasslands used through extensive management (CREMENE et al. 2004, BRINKMANN et al. 2009, JONES et al. 2010). Characteristic plant species are adapted to human land use, and grassland diversity is closely related to traditional as well as current management practices (POSCHLOD and WALLISDEVRIES 2002). In the Transylvanian Plain, traditional agricultural practices that have been mostly lost in Western Europe, such as extensive grazing and traditional mowing of grasslands, are still part of everyday agricultural life (AKEROYD 2006, BAŞNOU et al. . 2009)

1. The grasslands of the Transylvanian Plain

The Transylvanian Plain, sometimes called the Transylvanian Basin (45°40'–47°50' N and 23°00'–25°40' E), is a hilly area in central Romania. It is surrounded almost entirely by the Eastern, Southern and Western Carpathians of Romania (maximum altitude 2544 m above sea level), and its altitude varies between approximately 200 and 700 m. The climate is sub-continental, with average annual temperatures of 8 - 10 °C , while mean annual precipitation ranges from 520 to 700 mm, higher values typically found in the higher elevations of the East (POP 2001, KUN et al. 2004). The Transylvanian Plain is fragmented by numerous valleys, which generally flow from East to West. Different types of Eocene and Oligocene bedrocks predominate: clays, marls, sands and sandstones, while reef limestones are rare (TUFESCU 1974)

2. The management of grasslands in the Transylvanian Plain

In recent decades, some areas of grasslands have been subjected to intensification, and others to extensification to the point of abandonment. Therefore, actions have been initiated to improve this negative situation by creating reservation networks, declaring protected areas, granting subsidies to owners, etc. Efforts have been made both by organizations advocating for the conservation of nature and by those who use the grasslands for economic interests. In the common agricultural policies, the sustainable use of natural and semi-natural grasslands has been stimulated. Thus, semi-natural grasslands are increasingly valued for the ecosystem services they provide, such as unique biodiversity, carbon sequestration, water retention, heritage, reduced fire risks, etc., (BENGTSSON et al., 2019). At the European level, important grassland areas (30% of the total agricultural area) have been declared grasslands of high natural value

(HNV; LOMBA et al. 2014). HNV systems refer to those areas in Europe where agricultural activities support and are associated with high biodiversity (EIP-AGRI, 2016). According to the new National Strategic Plan 2023-2027, our country has one of the richest resources of grassland systems that can be classified as having a High Nature Value (HNV), as a result of the great variety of plant species associated with the land agricultural land used as permanent grassland, or through traditional mowing or grazing management. As in the case of permanent natural and semi-natural grasslands, the lack of mechanization with heavy machinery and the avoidance of the use of chemical inputs along with the application of traditional agricultural technologies (the application of extensive or semi-extensive management for grazing and mowing) will favor the maintenance of these habitats, of the traditional cultural background, but also of the biodiversity of these systems with high natural value

3. Research objectives

In the present work, we proposed two main objectives, the first consists in the study of the types of grasslands on the Turda resort lands, respectively the types of pastures located within the radius of the Turda municipality and the Bolduț locality, but also their analysis from the point of view of productivity and biodiversity. The second main objective involves the analysis of the floristic composition in an organized experiment, on the type of Festuca rupicola grassland. On the other hand, the study of the floristic composition will be carried out for each degree of fertilization, respectively the changes made in the floristic composition depending on the intensity of the applied management. More than that, it is desired to identify an optimal amount of fertilization so that the grassland biodiversity does not register major changes, but a significant increase in the production of the semi-natural grasslands in our study area is registered.

The secondary objectives of the doctoral thesis are:

I. presentation of the ecological and agronomic value of each type of grassland from the 2 locations studied, in the territory of SCDA Turda;
II. certification of the vegetation of each type of grassland;
III. the influence of organic, mineral and organo-mineral fertilization on the floristic composition, but also on the phytodiversity of grasslands;
IV. the influence of organic, mineral and organo-mineral fertilization on dry matter yield;
V. developing a list of species with indicative value for the intensity of organic, mineral and organo-mineral fertilization.

4. The natural setting

The Transylvanian Depression is famous for its extensive grasslands of various types, most of which have been used traditionally, until now, being mostly manually mowed or extensively grazed (LOOS et al., 2021). The experiences and floristic studies were carried out on the grasslands of the Turda Research and Development Station

(SCDA Turda), located in the northwestern part of the Turda municipality in the west of the Transylvanian Plain. The large area served or influenced by the resort includes the area of the intramontane geographical unit. The Transylvanian Depression, with the areas of: the Transylvanian Plain, the Someşean Plateau, the Târnavelor Plateau, the Sibiu, Făgăraş and Braşov Depressions, a geographical area administratively located in the territory of 11 counties. In the work from volume III Geografia României (1987) the delimitation and regionalization of the Transylvanian Depression in two units is shown. The central unit represented by the Transylvanian Plain and a marginal unit formed by the Submontane Hills and Depressions.

5. Materials and methods

5.1 Experiences undertaken

In order to be able to maintain the biodiversity of grasslands with high natural value in agricultural areas, an experiment was organized where the study of the floristic composition was carried out in order to identify an optimal amount of fertilization so that the biodiversity of the grasslands does not register major changes, but a significant increase in production of semi-natural grasslands in our study area. Experience was installed in the spring of 2018, on a semi-natural grassland in the Transylvanian Plain. Different methods of grassland vegetation research are used in the study of grassland systems. Phytopopulation indices are present in the evaluation of grassland vegetation: presence/absence, abundance, density, cover (dominance), abundance-dominance and frequency (CRISTEA et al., 2004; KENT, 2012). Our experiment was designed according to the method of randomized blocks, in four repetitions (blocks), with 6 experimental variants. The surface of an experimental plot was 20 m2. The experimental variants were the following: V1-semi-natural grassland (control), V2-10 t/ha litter, V3-10 t/ha litter + N50P25K25, V4- N50P25K25, V5- N100P50K50, V6-10 t/ha litter + N100P50K50.

Floristic studieswere made with the Braun-Blanquet abundance-dominance appreciation scale, completed by Tüxen and Ellenberg (1937), modified with three sub-notes and three sub-intervals by Păcurar and Rotar (2014), when the Poaceele were in the phase of flowering. The typological classification of grasslands was made according to ȚUCRA, 1987.

For processing the floristic data obtainedthe PC-ORD software with the new version 7 (www.pcord.com) was used in the experimental fields.In order to be able to observe the vegetation classification of the analyzed semi-natural grasslands and the changes in the types of identified grasslands, I used Cluster Analysis - PC-ORD 7. The ordering of the analyzed phytocenoses was done with PCOA (Principal Coordinates Analysis). The analysis and identification of indicator plant species was carried out with Indicator Species Analysis (ISA) using the method of Dufrene and Legendre 1991, this method assumes that there are two or more groups of sample units and that the abundance of the species was recorded in each of sample units (floristic surveys).

The experimental data on the productivity of the grasslands for each experimental year were processed with the analysis of variance, which is a statistical-mathematical method of processing the obtained data. The processing of these data was carried out with the PoliFact program.

6. Results and discussions

6.1 Ecological and agronomic analysis of semi-natural grasslands at SCDA Turda

One of the objectives of this doctoral thesis is to carry out the study of the floristic composition on the semi-natural grassland areas within the Turda Agricultural Research and Development Station. The floristic studies on the studied areas were carried out at the optimal time, in the summer of 2019. On the pasture at SCDA Turda, 8 grassland bodies were identified that belong to the following types (PD, figure 6.1), as follows: PD_Turda_1 - grassland type Lolium perenne – Poa annua; PD_Turda_2 - Festuca rupicola grassland type; PD_Turda_3 - Festuca rupicola grassland type; PD_Turda_4- grassland type Elymus elongatus - Festuca rupicola; PD_Turda_5 - grassland type Elymus repens - Koeleria macranta; PD_Turda_6 - type of grassland Festuca rupicola - Brachypodium pinnatum; PD_Turda_7 - perennial Lolium grassland type; PD_Turda_8 - type of grassland Festuca rupicola.

Following the floristic studies on the grassland in the Bolduț locality, the following types of grassland were identified, as follows: PD_ Bolduț _1 - Brachypodium pinnatum - Arrhenatherun elatius grassland type; Bolduț _2 - type of grassland Festuca rupicola; PD_ Bolduț _3 - type of grassland Festuca rupicola - Agrostis capillaris; PD_ Bolduț _4 - type of grassland Festuca rupicola – Festuca valesiaca; PD_ Bolduț _5 - Brachypodium pinnatum grassland type; PD_ Bolduț _6 - Lolium perenne grassland type.

6.2. The influence of mineral and organic fertilizers on the floristic composition of grasslands *Fescue rupicola*

Based on the cluster analysis, the classification of the vegetation and the modification of the type of grasslands can be observed due to the floristic distances between them. Each amount of fertilizer applied determined a certain floristic composition. The first group is represented by variant 1 and variant 2. The second group is represented by variant 3, and the last group by variants V4, V5 and V6. The application of fertilizers on HNV semi-natural grasslands determines a clear classification of phytocenoses. The floristic composition of the pastures is a reflection of the phytocenosis and the applied management.

Regarding the analysis with the help of PCOA (Principal Coordinates Analysis) it can be observed that the phytocenosis of the control is represented by the Festuca rupicola type. In variants V2, V3 and V4, 2 years after the application of inputs, there were only changes within the phytocenosis, without changes in the type of grassland. In

fact, a significant change in the level of grass cover occurs when the amount of fertilizers increases – namely, for the application with N100P50K50 kg/ha (V5), respectively, and the application of the combination of mineral and organic fertilizers (V6).

6.2.1. The effects of fertilization on grassland biodiversity (number of species)

In the phytocoenosis of the control, we identified a total of 42 species. When the amount of 10 t/ha−1 manure was applied, small changes were recorded at the level of the floristic composition. In this phytocenosis (V2), we identified 39 plant species, which were recorded in the floristic composition. Therefore, three plant species disappeared from the phytocoenosis of the control (V1). When applying 10 t/ha−1 manure + N50P25K25 (V3), 36 plant species were identified in the floristic composition. Compared to the control variant, it was observed that there was an important change in the floristic composition, six plant species disappeared from this phytocenosis. Compared to the control variant, a loss of biodiversity can be observed for HNV grasslands in the study area. The richness of the number of plant species is determined by the type of fertilizer applied, but especially by the dose of fertilizers administered.

6.2.2. Species with indicative value (organic and mineral fertilization)

One of the objectives of this research was to identify plant species with indicative value for each degree of fertilization applied, for the type of fertilizer applied. 36 plant species were identified in the phytocenosis of the control (V1). The absence of fertilizer application was highlighted in many plant species, most species having a very significant indicator value. In the phytocenosis of the control (V1), 12 plant species with indicative value were identified, where 10 t/ha−1 manure was applied (V2), five plant species with indicative value were identified. The application of 10 t/ha−1 manure + N50P25K25 (V3) determined the establishment of nine plant species with indicative value, the application of N50P25K25 (V4), highlighted only one indicator species. Application with N100P50K50 (V5), in the floristic composition, eight species with indicative value were identified. When applying 10 t/ha−1 manure + N100P50K50 (V6), a total of seven plant species with indicative value were identified in the floristic composition.

6.2.3. The influence of organic fertilization on agronomic spectra

Dry matter production increases proportionally as the amounts of fertilizers applied increase. The harvest correlates significantly (r = 0.698; Figure 6.20) with the treatments applied, but especially with those applied in variant 6 (maximum fertilization degree). The productivity of Festuca rupicola grasslands (control) is 1.19 t/ha−1 (SU), and after the application of the treatments it increases up to 2.05 t/ha−1. The yield difference between the control variant and the application of the 10 t/ha−1 manure treatment resulted in significant increases in dry matter (0.25 t/ha−1 SU). Increasing amounts of fertilizers recorded higher production increases, but at the same

time decreased the biodiversity of HNV grasslands. Thus, the application of organic fertilizers in moderate doses of 10 t/ ha−1 manure registers a significant increase in the harvest, but at the same time, an insignificant reduction in the diversity of HNV grasslands is found. Consequently, the application of mineral fertilizers in doses of N50P25K25 does not produce an imbalance in the phytocenosis, recording an increase in biomass but with a minimal decrease in the number of plant species in the floristic composition.

6.2.4. Influence fertilizers on the production of Festuca rupicola grasslands

As part of our experience, it was aimed to increase the harvest of SU by applying organic and mineral fertilizers, experience located in the non-moral zone - Transylvanian Plain on a type of grassland*Fescue rupicola*. As expected, since the first year (2018), the beneficial effect of organic and mineral fertilizers on the SU harvest can be observed, through the yield increases achieved by the fertilized variants, compared to the control variant. In the first year, the highest dry matter yield, compared to the control, is obtained in the case of the variant with 10 t/ha−1 manure + N100P50K50, of 3.58 t/ha SU (150.5%), and the weakest in the variant with 10 t/ha of garbage, of 2.53 t/ha (106.3%). In the variant with 10 t/ha of manure, the difference in harvest compared to the control is insignificant, on the other hand, in the case of the variants with V4 (N50P25K25), V5 (N100P50K50) and V6 (10 t/ha−1 manure +N100P50K50) differences are statistically assured. The effect of manure on the SU harvest is minimal in the first year and maximal in the second year, after which it gradually decreases, a fact observed over time by numerous researchers in this field (NEMEŞ, 1961, SAVATI, 1971, ŞERBAN, 1982 , MARIANA RUSU, 1997, etc.).

Regarding the analysis of the dry matter harvest over the entire experimental period (2018-2021), the difference in harvest determined by the application of mineral and organic inputs are, in general, ensured statistically with the exception of the treatment with mineral fertilization in the dose of N50P25K25, when achieves a difference of only 0.10 t/ha SU and which does not present statistical assurance (table 6.58). The maximum level of harvest achieved in the variants with high doses of fertilizers is much higher compared to that recorded in the control variant and presents distinctly significant statistical assurance. We could thus affirm that the reaction of the phytocenosis to the application of organic and mineral inputs depends on the climatic conditions of a year and the physical-chemical properties of the soil. The utilization of mineral fertilizers on the type of Festuca rupicola grassland is very different from one year to another, depending on the recorded climatic conditions.

Concluzion

1. Following the analysis of the floristic composition of the grassland in Turda, several types of grasslands were identified as follows: Lolium perenne grassland type - Poa annua, Festuca rupicola, Elymus elongatus - Festuca rupicola, Elymus repens - Koeleria macranta, Festuca rupicola - Brachypodium pinnatum, perennial Lolium;
2. Following the analysis of the floristic composition on the grassland in Bolduț locality, the following types of grasslands were identified as: Festuca rupicola, Festuca rupicola - Agrostis capillaris, Festuca rupicola - Festuca valesiaca, Brachypodium pinnatum, Lolium perenne.
3. The application of inputs to Festuca rupicola grasslands causes changes in the vegetal carpet level, which result in the change of dominance and co-dominance between species, respectively the installation of new types of grasslands.
4. Each amount of applied fertilization, whether organic or mineral, determines a particular floristic composition.
5. The application of fertilizers strongly influences the participation of species causing the disappearance or emergence of new species.
6. Significant changes in the floristic composition occur when mineral fertilizers are applied in moderate to large amounts, namely in amounts such as N100P50K50.
7. The application of fertilizers in the moderate amount of 10 t/ha of manure or the application of chemical fertilizers N50P25K25 do not produce major changes in the floristic composition, at the same time it does not endanger the biodiversity of grasslands with high natural value (HNV), but at the same time it also brings an increase of the harvest of SU.
8. Following the application of inputs (organic and mineral), a number of species with indicative value resulted.
9. For the phytocenosis of the control, 12 indicator species were identified, and when applying 10 t/ha of manure, five plant species with indicator value were identified.
10. The treatment with 10 t/ha manure + N50 P25 K25 (V3) led to the identification of 9 species with indicative value. Regarding the application of N50P25K25 (V4), it revealed only one indicator species (Poa pratensis).
11. The application of the last fertilization gradations, namely N100P50K50 (V5), determined the identification of 8 species with indicative value, and V6 (10 t/ha manure + N100P50K50) has in its floristic composition a number of 7 species with indicative value.
12. The productivity of Festuca rupicola grasslands increases proportionally as the amounts of fertilizers applied increase.

The originality and innovative contributions of the thesis

Analysis by result or with the help of species with indicative value has been carried out in some Western European countries since 1992 (BRIEMLE, 2003; GUJER, 2005). The subsidy was granted to the applicants only if at least 4 species of plants with indicative value from a predetermined list were identified in the grassland of the property. At the same time, the list of species with indicative value indicates the degree of intensiveness of the grassland systems. Currently, many researchers recommend Common Agricultural Policies, evaluation by result (and not by action, as is currently practiced) at the level of the entire European Community (ÓHUALLACHÁIN et al., 2018) and the development of lists of species with indicative value (GARCÍA-DE -LA-FUENTE et al., 2018). Sooner or later, this way of assessment will also be implemented in our country. Two brochures in this regard also appeared on the APIA website (https://rb.gy/1adrmj). Only the association of the information provided by the preferences of the plant species to the ecological, agronomic and anthropic factors allows us to evaluate semi-natural grassland ecosystems and even to capture the practical management applied.

An even greater challenge is the development of management plans for HNV systems. Forecasting the reaction of plant species to certain management measures is quite difficult, if not based on organized experiences. Such researches are very rare in our country. Even if specialized literature in the field is used, which is based on experiences from other regions of the world, the results can often be far from reality. In recent years these HNV systems are increasingly threatened in our country. If in the second evaluation of HNV in our country, in the period 2014-2020, we had a total area of approximately 2 million ha of High Natural Value grasslands (HNV), according to the new National Strategic Plan 2023-2027 which brings new regulations regarding the impact resulting from the implementation of commitments for agro-environment and climate adapted to the management of these areas with high natural value, resulted in an eligible surface of only approximately 1.360 million hectares, related to a number of 768 UATs. Therefore, in the case of our research, we focus on these important and beneficial systems for rural communities.

Selective Bibliography

1. ERHARDT, A., & THOMAS, JA (1991). Lepidoptera as indicators of change in the semi-natural grasslands of lowland and upland Europe. The conservation of insects and their habitats, 112, 213-236.

2. ADLER, PB, LAUENROTH, WK (2000). Livestock exclusion increases the spatial heterogeneity of vegetation in Colorado shortgrass steppe. Applied Vegetation Sciences 3: 213-222.

3. AKEROYD, J. (2006). The historic countryside of the Saxon villages of southern Transylvania. – ADEPT Foundation, Saschiz, Mureş: 86 pp.

4. CSURÖS, I., RESMERIŢĂ, I., CSURÖS-KÁPTALAN, M., GERGELY, I. 1961. Grasslands from the Transylvanian Lowland and considerations about their management . Studia Universitatis Babeş-Bolyai, Biology 2: 15-61.

5. CSUROS, S., CSUROS-KAPTALAN, M., & RESMERITA, I. (1970). Ecological indices: humidity, temperature, soil reaction and fodder value of the most important species in the grasslands of Transylvania. II. Cluj Univ Babes bolyai Stud Ser Biol.

6. DONIŢĂ, N., IVAN, D., & COLDEA, G. (1992). Vegetation of Romania. Agricultural Technical Publishing House.

7. ELSAESSER, M. (2004). Optimum management intensity of legume- and grass-based grassland swards. In Land use systems in grassland dominated regions. Proceedings of the 20th General Meeting of the European Grassland Federation, Luzern, Switzerland, 21-24 June 2004 (pp. 510-512). vdf Hochschulverlag AG an der ETH Zurich.

8. EM BIGNAL, DI MCCRACKE (1996) Low-intensity farming systems in the conservation of the countryside, Journal of Applied Ecology.

9. ENYEDI, ZM, RUPRECHT, E., DEÁK, M. (2008). Long-term effects of the abandonment of grazing on steppe-like grasslands. Applied Vegetation Science 11: 53-60.

10. F. PACURAR, I. ROTAR, (2014) Study methods and interpretation of grassland vegetation. Risoprint, 2014. 61.

11. MOTCA, G., BURCEA, P., BARBULESCU, C., ION, T., & MARINICA, D. (1978). The influence of doses and periods of application of nitrogen fertilizers on temporary grasslands from Davidesti, Arges County

1. .PĂCURAR, FS, ROTAR, I., & VAIDA, I. (2019). The effects of wild boar disturbances on the agronomical value of semi-natural grasslands. Romanian J. Grassl. Forage Crops, 20, 27.

2. PĂCURAR, F., & ROTAR, I. (2004). Maintaining biodiversity and increasing the production of dry matter on mountain grasslands. In Land use systems in grassland dominated regions. Proceedings of the 20th General Meeting of the European Grassland Federation, Luzern, Switzerland, 21-24 June 2004

3. PĂCURAR, F., BALAZSI, A., ROTAR, I., VAIDA, I., REIF, A., VIDICAN, R., & SANGEORZAN, D. (2020). Technologies used for maintaining oligotrophic grasslands and their biodiversity in a mountain landscape. Romanian Biotechnol. Lett, 25, 1128-1135.

4. PĂCURAR, F., ROTAR, I., VAIDA, I., VIDICAN, R., & MĂLINAŞ, A. (2017). Indicator species of fertilization intensity in mountain grasslands. Grassland resources for extensive farming systems in marginal lands: major drivers and future scenarios, 378.

5. PECO, B., SÁNCHEZ, AM, AZCÁRATE, FM (2006). Abandonment in grazing systems: Consequences for vegetation and soil. Agric. Ecosyst. Environment. 113: 284-294.

6. ROTAR, I., CIREBEA, M., VIDICAN, R., PĂCURAR, F., MĂLINAŞ, A., & RANTA, O. (2015). Productivity of Festuca rubra L.-Agrostis capillaris L. grasslands.

7. ROTAR, I., (2003). The influence of fertilization on Festuca rubra pasture biodiversity. Bulletin UASMV Cluj-Napoca, Agriculture.

12. ROTAR, I., PACURAR, F., VIDICAN, R. AND SIMA, N., (2003). Effects of manure/sawdust fertilization on Festuca rubra type grasslands at Ghetari (Apuseni Mountains). In Optimal forage systems for animal production and the environment. Proceedings of the 12th Symposium of the European Grassland Federation, Pleven, Bulgaria, 26 -28 May 2003 (pp. 192-194). Bulgarian Association for Grassland and Forage Production (BAGFP).

13. ROTAR I., PĂCURAR F., BOGDAN ANCA, VIDICAN ROXANA, NAGY M. (2014) Ecological and agronomic aspects of Agrostis capillaris L. – Trisetum flavescens LP Beauv grassland subtype. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Agriculture Series. 71(2):295-301.

14. ROTAR I., PĂCURAR F., NICOLETA GġARDA, ROXANA VIDICAN. (2009). Arnica montana L. – a valuable medicinal plant of the oligotrophic grasslands, Bulletin UASVM Cluj-Napoca, Agriculture series, vol. 66, 471-476.

15. ROTAR, I., & CARLIER, L. (2010). Grassland culture. Risoprint.

16. ROTAR, I., A. STOIE, ROXANA VIDICAN (2011). Productivity and interspecific relations in the grasslands with Arnica montana in Gârda, Romania during 2006, Grassland Science in Europe, 16, 535-537.

17. SAMUIL C., VINTU V., IACOB T., POPOVICI IC, STAVARACHE M, MUNTEANU I. (2010) - Possibilities to improve the Festuca valesiaca L. permanent grasslands from NE of Romania. Scientific works, Agronomy series, vol. 53. Ion Ionescu Publishing House from Brad Iaşi. ISSN 1454-7414.

18. SAMUIL, C., STAVARACHE, M., SIRBU, C., & VINTU, V. (2018). Influence of Sustainable Fertilization on Yield and Quality Food of Mountain Grassland. Notulae Botaniae Horti Agrobotanici Cluj-Napoca, 46(2), 410-417

19. VAIDA, I., PĂCURAR, F., ROTAR, I., TOMOŞ, L., & STOIAN, V. (2021). Changes in diversity due to long-term management in a high natural value grassland. Plants, 10(4), 739.

20. VËNTU, V., SAMUIL, C., ROTAR, I., MOISUC, A., & RAZEC, I. (2011). Influence of the management on the phytocoenotic biodiversity of some Romanian representative grassland types. Notulae Botaniae Horti Agrobotanici Cluj-Napoca, 39(1), 119-125.

21. VËNTU, V., MOISUC, A., MOTCĂ, G., & ROTAR, I. (2004). Cultivation of grasslands and fodder plants. "Ion Ionescu de la Brad" publishing house.

22. VINTU, V., SAMUIL, C., POPOVICI, IC, & SAGHIN, G. (2010). Improving grasslands of Agrostis capillaris and Festuca rubra in the Carpathian Mountains of Romania by organic fertilization. Grassland in a changing world, 310.