CLASSIFICATION OF THE GRASSLANDS BELONGING TO NADRAG LOCALITY USING THE MULTIVARIATE ANALYSIS METHODS

C. BÂRLIBA , Luminița COJOCARIU

Banat's University of Agricultural Sciences and Veterinary Medicine, Faculty of Agricultural Sciences, Timisoara, Aradului Street, no. 119, RO-300645, Romania,
Corresponding author: barlibacostel@yahoo.com

Abstract: *In order to increase the production of the permanent grasslands and of grassland quality it is necessary to generalize some technologies elaborated basing on several scientific researches. However, these conditions must be differently applied depending on the local station conditions and on the real production capacity of each type of grassland. The production capacity of a grassland is determined by the production capacity of the vegetation and by the production capacity of the land used as grassland (Horablaga M. si Luminita Cojocariu, 2006). Among all factors that influence the grassland existence, the vegetation expresses in the most concrete and appropriate way the basic features of a grassland (Marusca T., 2001; Hubert F., Pierre P., 2003; Horablaga M., Luminița Cojocariu, 2006).The goal of this paper is to try classifying the grasslands belonging to Nădrag locality and to demonstrate this classification basing on a mathematical analysis, taking into consideration several factors: grassland surface, land declivity (slope), general cover, specific cover, and the main plant species which compose the grassland vegetation. The study objective is represented by nine grassland surfaces belonging to Nădrag locality, placed at various altitudes between 190-1370 m. Basing on the plant relevés, there were determined the grassland type and the percentage of the graminaceous, leguminoses and other various plants participating on the floristic composition of each grassland (Daget Ph., Poissonet J.; Kovacs J. Attila, 1979). There was also determined the vegetation cover degree in order to make an overview on the grasslands put in discussion. Basing on a topographic analysis, we determined the precise surface of the plots, the land limits, altitude and slope for every single plot. Basing on all field data, we succeeded to enclose the nine studied grasslands in three classes and moreover we demonstrated those factors on which this classification is relying. There was performed a classification of the analyzed plots by Ward's method in cluster analysis using the Euclidean distance. The plots P6, P7, P10A, P11C are in the same cluster and the parcel P9 is the closest to this cluster. The parcels P1B, P1C, P2B and P5B formed a new cluster.*

Key words*: *grassland surface, topographic analysis.

INTRODUCTION

Since 1928, Braun- Blanquet and Pavillard considered that the separately estimation of the abundance and dominance never can be applied, excepting the relative small surfaces, reason for why they proposed an indicator of abundance-dominance (AD) and a numerical system of evaluation.

Dominance is that quantitative indicator through which can be estimated the surface occupied by the horizontal projection of the supra-terrestrial plant parts above the soil, in a well delimited area within a phytocoenosis. By its values, the dominance codifies the curdling degree of the vegetation, the ratio volume/surface of the photosynthesis apparatus for various plant species in the grassland. Referring to the projective surface of the supra-terrestrial plant parts, the dominance is also known under the name of covering degree, and within a phytocoenosis could be found the followings: the general covering meaning the projection of the supra-terrestrial plant parts of all species (sample surface); the specific covering which means the projection of all individuals belonging to a certain species within the area.

MATERIAL AND METHODS

This indicator AD was and still is the most used in the phytosociology practice, and the estimation system was improved by Tuxen and Ellenberg, which enounced the percentage values for each point on the scale, and also the value of the mean abundance-dominance (AD_m).

Knowing the value of each point on the scale, the estimation (in the case of grassland vegetation) is made regarding from above the sample area and estimating the proportion of its coverage realized by the supra-terrestrial parts of all plant individuals. Thus, it is obtained the value of the general abundance-dominance (or general coverage), which is noted in the observation form as percents. The next stage, more difficult and based on flora knowledge, consists of giving an AD index for every single plant, depending on coverage percentage realized by the supra-terrestrial projection of all individuals of the species. In this way it is estimated the specific coverage, whose totalized values must be close to that expressed by the general coverage.

As method for taxonomic identification of the vegetation we used the geo-botanic method. After the sample area delimitation, it is realized the geo-botanic sheet. After recording the species in the sheets, each species will be characterized by the main features: abundance, dominance, frequency, and phenophase. Usually, the dominance and abundance are expressed associated (AD). After the geo-botanic sheets were realized, these are centralized and then grouped in associations and will be made the association table. The association is named after the name of one or two species dominant in the association by adding the suffix –etum to the genus name, and the name of the species is put in the genitive case (HORABLAGA M., LUMINIȚA COJOCARIU, 2006).

The statistical analysis had been perfomed using the package STATISTICA 8 [MEAD R., R.N. CURNOW and A.M. HASTED,2002; PETERSEN R.G.]. The cases taken in our statistical analysis were the plots P1B, P1C, P2B, P5B, P6, P7, P9, P10A, P11C from Nadrag. The variables Sha, Incl, ADg, Gram, Poa, Chrys, Agro, Fest, Lol were analyzed, and respectively the plot surface (ha), the plot slope, the general coverage of the plot, the percentage of the graminaceous, *Poa pratensis*, the percentage of the plot surface covered by *Chrysopogon gryllus*, , the percentage of the plot surface covered by *Agrostis tenuis*, the percentage of the plot surface covered by *Festuca (ovina or valesiaca)*, the percentage of the plot surface covered by *Lolium perenne*.

RESULTS AND DISCUSSIONS

The basic descriptive statistics are presented in Table 1 and the correlation matrix in Table 2. It was observed very strong positive correlations between the variables Poa and Chrys (0,96), Agro and Fest (0,88), Agro and Lol (0,86). Strong negative correlations between the variables Poa and Agro (-0,6), Poa and Fest (-0,8), Chrys and Agro (-0,8), Chrys and Fest (-0,9), Chris and Lol (-0,66), there was also noticed.

The Principal Component Analysis (PCA) has been performed on the 9 variables for the reference group with 9 cases. The results of PCA are shown in Table 3 to Table 6 and Figure 1 to Figure 3. The eigenvalues of the correlation matrix, the percent of total variance, the cumulative eigenvalues, and the cumulative percent are shown in Table 3. There are 7 eigenvalues arranged in decreasing order, indicating the importance of the respective factors in explaining the variation of the data. Let us observe (see Figure 1) that the largest eigenvalue (4,83) accounts for approximately 53,6% of the total variance and the second factor corresponding to the second eigenvalue (2,5) accounts for approximately 27,84% of the total variance, so the first and the second factors explain approximately 81,5% cumulative variance.

Table 1

The basic descriptive statistics

	Descriptive Statistics				
Variable	Valid N	Mean	Minimum	Maximum	Std.Dev.
Sha	9	13,45556	2,60000	61,0000	19,21179
Incl	9	18,66667	10,00000	25,0000	4,27200
ADg	9	78,88889	60,00000	100,0000	13,64225
ADs	9	73,88889	60,00000	80,0000	6,97217
Poa	9	17,77778	0,00000	30,0000	12,01850
Chrys	9	8,88889	0,00000	20,0000	10,54093
Agro	9	18,88889	10,00000	30,0000	10,54093
Fest	9	18,88889	10,00000	30,0000	9,27961
Lol	9	6,11111	0,00000	20,0000	6,97217

Table 2

The correlation matrix

	Correlations matrix								
Variable	Sha	Incl	ADg	ADs	Poa	Chrys	Agro	Fest	Lol
Sha	1,000000	-0,080619	-0,273971	-0,616326	-0,611685	-0,403958	-0,182981	0,184092	-0,250616
Incl	-0,080619	1,000000	0,271678	0,069945	0,348960	0,296093	-0,092529	-0,262765	-0,027978
ADg	-0,273971	0,271678	1,000000	0,773908	-0,093180	-0,270434	0,598817	0,383990	0,671694
ADs	-0,616326	0,069945	0,773908	1,000000	-0,107736	-0,359066	0,831522	0,558140	0,800000
Poa	-0,611685	0,348960	-0,093180	-0,107736	1,000000	0,964764	-0,613941	-0,809470	-0,488958
Chrys	-0,403958	0,296093	-0,270434	-0,359066	0,964764	1,000000	-0,800000	-0,908739	-0,661438
Agro	-0,182981	-0,092529	0,598817	0,831522	-0,613941	-0,800000	1,000000	0,880341	0,869318
Fest	0,184092	-0,262765	0,383990	0,558140	-0,809470	-0,908739	0,880341	1,000000	0,601074
Lol	-0,250616	-0,027978	0,671694	0,800000	-0,488958	-0,661438	0,869318	0,601074	1,000000

Table 3

The cumulative percent

	Eigenvalues of correlation matrix			
Value number	Eigenvalue	% Total variance	Cumulative Eigenvalue	Cumulative %
1	4,830037	53,66707	4,830037	53,6671
2	2,506305	27,84783	7,336341	81,5149
3	1,003123	11,14581	8,339464	92,6607
4	0,366631	4,07367	8,706094	96,7344
5	0,277080	3,07867	8,983174	99,8130
6	0,014343	0,15937	8,997518	99,9724
7	0,002482	0,02758	9,000000	100,0000

Because the analysis is based on the correlation matrix, the results displayed in the Table 4 can be interpreted as the correlations of the respective variables with each factor. Thus, we can conclude that the first component (corresponding to the first eigenvalue) is the linear combination:

$$Y_1=0,005*Sha+0,07*Inc-0,28*ADg-0,34*Gram+$$
$$+0,33*Poa+0,40*Chrys-0,44*Agro-0,41*Fest-0,39*Lol$$

and the second component (corresponding to the second eigenvalue) is the linear combination:

$$Y_2= 0,55*Sha-0,28*Inc-0,35*ADg-0,40* Gram -$$
$$-0,42*Poa-0,29*Chrys-0,08*Agro-0,16*Fest-0,17*Lol.$$

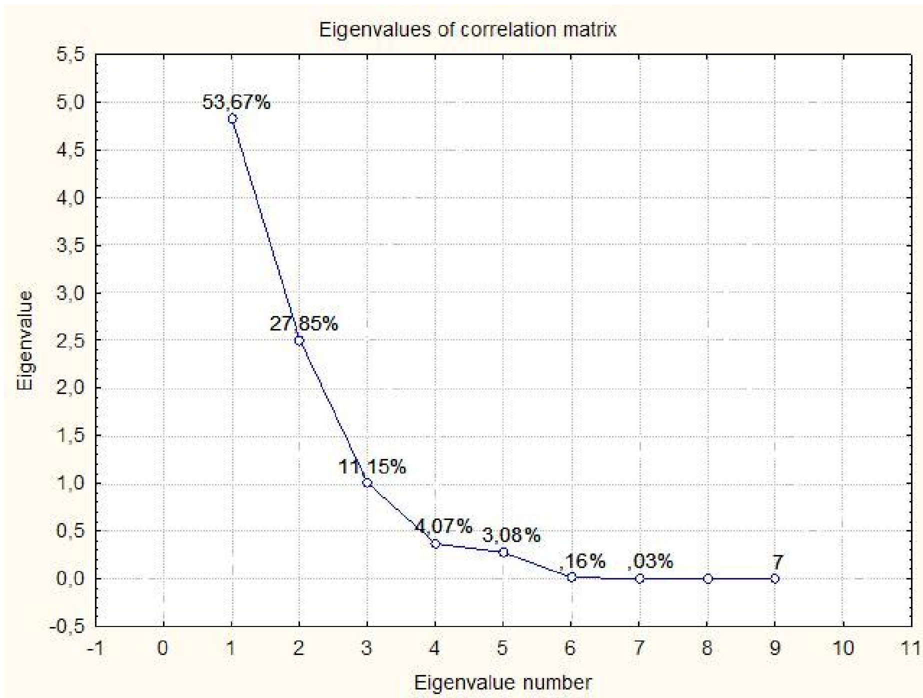

Figure 1. The cumulative percent

Table 4

Eigenvectors of correlation matrix

	Eigenvectors of correlation matrix						
Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Sha	0,005723	0,552724	0,441501	0,307896	-0,051704	-0,423509	0,471918
Incl	0,076905	-0,286716	0,828359	-0,457013	0,040837	0,017256	-0,121960
ADg	-0,281292	-0,350270	0,302286	0,740551	-0,242757	0,293441	-0,115563
ADs	-0,342989	-0,400124	-0,118175	-0,060720	-0,175735	-0,679041	-0,005669
Poa	0,332745	-0,423207	-0,089467	0,014192	-0,165344	-0,078626	0,477403
Chrys	0,400618	-0,292551	-0,054022	0,100077	-0,105787	-0,196340	0,135244
Agro	-0,443079	-0,087406	-0,041949	-0,267866	-0,059681	0,409726	0,682915
Fest	-0,413018	0,163072	-0,029419	-0,230721	-0,565828	-0,130421	-0,186968
Lol	-0,398960	-0,174868	0,002654	0,095056	0,737288	-0,208619	0,038708

It can be noticed (see Table 5 and Figure 2) that the first factor is strongly positive correlated with the variables *Poa* and *Chrys*, and strongly negative correlated with the variables *Agro, Fest*, *Lol*. The second factor is strongly positive correlated with the variable Sha and negative correlated with *Poa, Chrys* and even Incl, ADg, Gram. The circle in the Figure 2 provides a visual indication (scale) of how well each variable is represented by the factors Y_1 and Y_2 ; the closer a variable in this plot is located to the unit circle, the better is its representation by the current coordinate system. One interesting result shown in Figure 2 is that the variables are clustering, another proof of the highly correlation between the variables in the same cluster.

Table 5

Variable	Factor coordinates of the variables, based on correlations						
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Sha	0,012577	0,875035	0,442190	0,186431	-0,027216	-0,050721	0,023512
Incl	0,169017	-0,453909	0,829651	-0,276722	0,021496	0,002067	-0,006076
ADg	-0,618206	-0,554524	0,302758	0,448404	-0,127783	0,035144	-0,005758
ADs	-0,753798	-0,633448	-0,118360	-0,036766	-0,092504	-0,081324	-0,000282
Poa	0,731285	-0,669992	-0,089607	0,008594	-0,087034	-0,009417	0,023785
Chrys	0,880452	-0,463147	-0,054107	0,060597	-0,055684	-0,023514	0,006738
Agro	-0,973770	-0,138376	-0,042015	-0,162193	-0,031415	0,049070	0,034024
Fest	-0,907704	0,258164	-0,029465	-0,139702	-0,297843	-0,015620	-0,009315
Lol	-0,876809	-0,276839	0,002658	0,057557	0,388096	-0,024985	0,001928

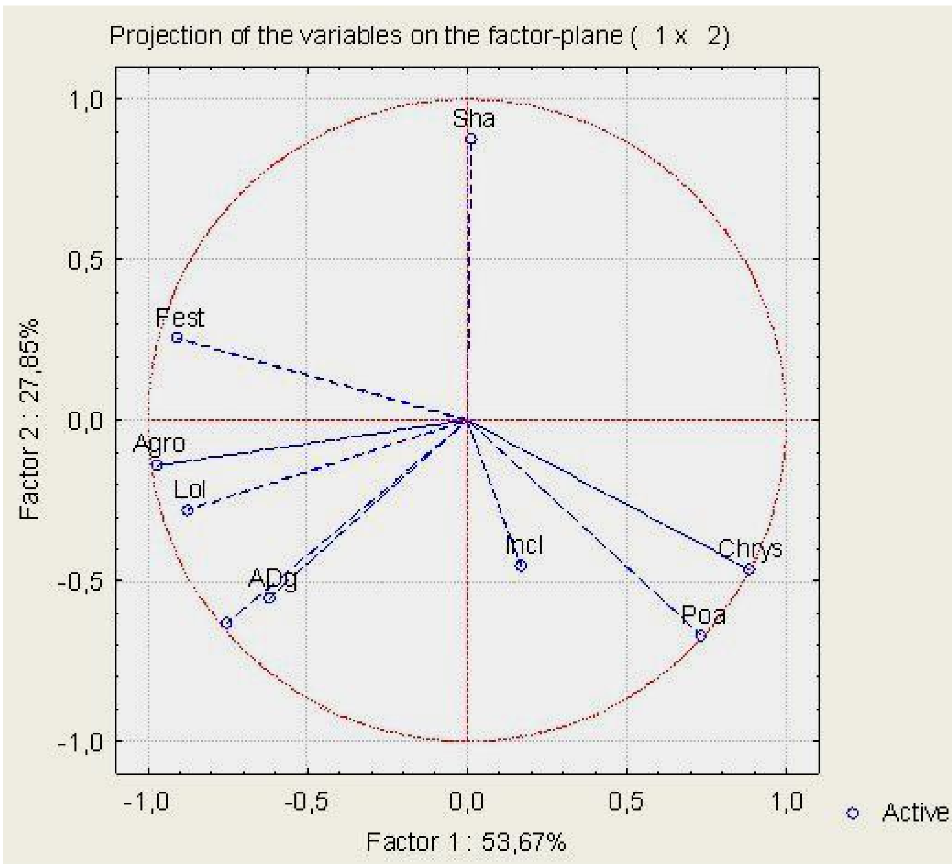

Figure 2 . Projection of the variables on the factor plane

Table 6 reveals the coordinates of the observations corresponding to the new factors associated with the eigenvalues and eigenvectors of the correlation matrix. It can be noticed the relevance of the two first coordinates.

Table 6

Case	Factor coordinates of cases, based on correlations						
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
P1B	2,27502	-0,61550	-0,20638	-0,28017	-0,035672	0,105390	-0,026467
P1C	2,07029	-0,73128	0,12781	0,34120	-0,226804	0,212471	0,009187
P2B	2,51781	-0,43544	0,00581	-1,00491	0,156009	-0,145717	0,050273
P5B	1,29556	-1,30931	-0,15573	1,09858	-0,017120	-0,184018	-0,031577
P6	-2,22007	0,41628	-1,98344	0,16110	-0,360401	0,008832	0,060963
P7	-2,07525	-0,04296	-0,37016	-0,65146	-0,291193	-0,018373	-0,101104
P9	0,86472	4,01520	0,40592	0,25938	0,193311	-0,012905	-0,008563
P10A	-2,37263	-0,86624	0,27014	0,05918	1,217746	0,050540	0,009177
P11C	-2,35545	-0,43074	1,90603	0,01711	-0,635877	-0,016220	0,038111

The projection of the observations on the plane determined by the two first factors Y_1 and Y_2 is shown in Figure 3. It can be noticed the similarity of P6, P7, P11C, P10A, and also P1B, P1C, P2B and P5B. This similarity had been also highlighted by another method (see Figure 4).

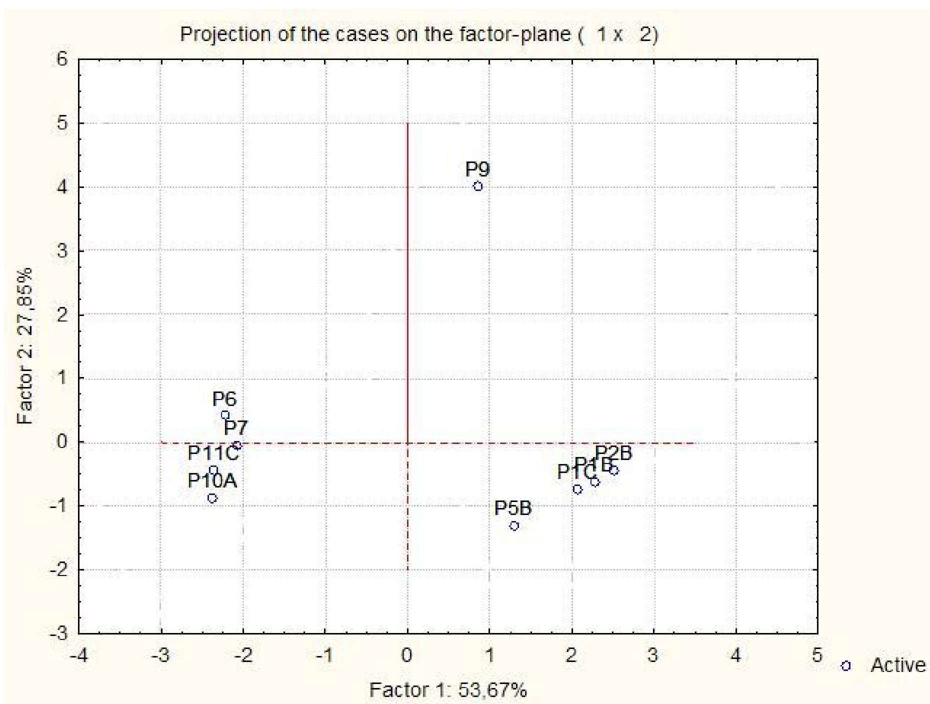

Figure 3. Projection of the cases on the factor plane

It was performed a classification of the analyzed beet genotypes by Ward's method in cluster analysis using the Euclidean distance. The genotype plots P6, P7, P10A, P11C are in the same cluster and the plot P9 is the closest to this cluster (see Figure 4). The plots P1B, P1C, P2B and P5B formed a new cluster.

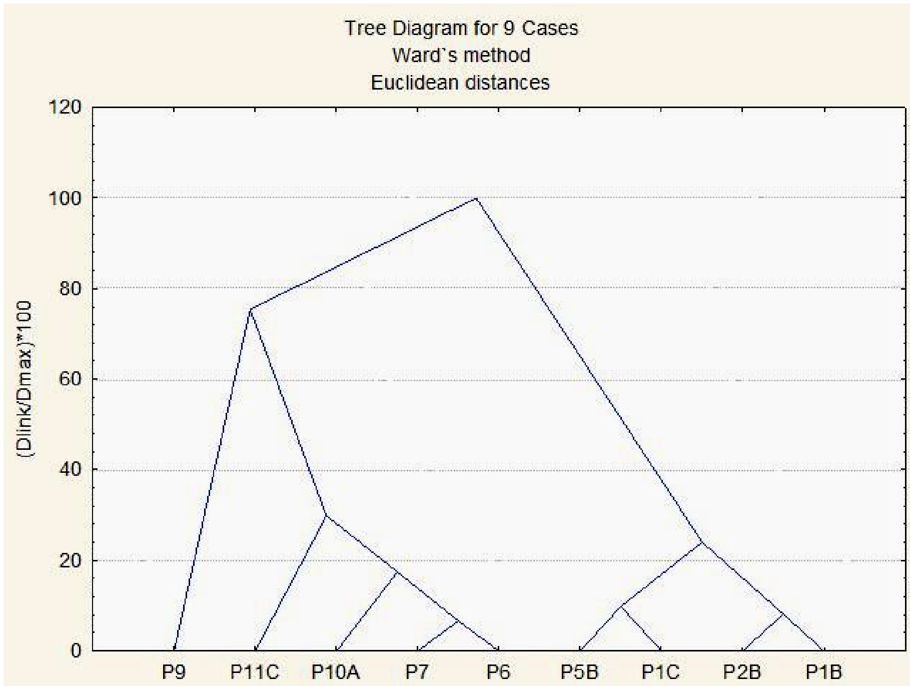

Figure 4. Tree Diagram for 9 cases

CONCLUSIONS

It was observed (see Table 2 and Figure 2) a very strong positive linear correlation between the percentage of the plot surface covered by *Poa pratensis* and the percentage of the plot surface covered by *Chrysopogon gryllus*, the percentage of the plot surface covered by *Agrostis tenuis* and the percentage of the plot surface covered by *Festuca sp*., the percentage of the plot surface covered by *Agrostis tenuis* the percentage of the plot surface covered by *Lolium perenne*.

A strong negative linear correlation has been observed between the percentage of the plot surface covered by *Poa pratensis* and the percentage of the plot surface covered by *Agrostis tenuis*, the percentage of the plot surface covered by *Poa pratensis* and the percentage of the plot surface covered by *Festuca sp*., the percentage of the plot surface covered by *Chrysopogon gryllus* and the percentage of the plot surface covered by *Agrostis tenuis*, the percentage of the plot surface covered by *Chrysopogon gryllus* and the percentage of the plot surface covered by *Festuca sp.*, and respectively the percentage of the plot surface covered by *Chrysopogon gryllus* and the percentage of the plot surface covered by *Lolium perenne*. A visual evidence of the correlations mentioned above is also the clustering trend noticed in *Figure 2*.

By the Ward's method in cluster analysis using the Euclidean distance (see Figure 4), the similarities between the plots P1B, P1C, P2B,P5B , and the similarities between P6, P7, P10A, P11C were pointed out.

Basing on all field data, we succeeded to enclose the nine studied grasslands in three classes and moreover we demonstrated those factors on which this classification is relying.

BIBLIOGRAFY

1. BADEA G.O. , " Măsurători Terestre-fundamente ", volumul I, Topografie, Editura Matrix Rom, Bucureşti, Romania, 2002.
2. BOŞ. N., 1992, Topografie, Editura Didactică şi Pedagogică, Bucureşti.
3. BURGHELEA D.,1995, Drept funciar şi cadastru român, Editura Moldova .
4. DAGET Ph., POISSONET J., 1971 - Une methode d analyze phytoecologice des praires. Criteres d aplication, An. Agron., no.22.
5. HORABLAGA M., Luminiţa COJOCARIU, 2006 – Managementul pajistilor şi al culturilor furajere, editura Eurostampa, Timisoara, pg.212-214.
6. HUBERT F., PIERRE P., 2003 - Guide pour un diagnostique prairial, Chambred D Agriculture.
7. KISS A.,1997, Topografie, Universitatea Transilvania, Editura Lux Libris, Braşov.
8. KOVACS J. Attila, 1979 – Indicatorii biologici, ecologici şi economici ai florei pajiştilor , Bucuresti, Lito.
9. MARUSCA T. , 2001 – Elemente de gradientică şi ecologie montană, editura Universităţii Transilvania din Braşov.
10. MEAD R., R.N. CURNOW and A.M. HASTED - Statistical Methods in Agriculture and experimental Biology, 3rd Edition, Texts in Statistical Science, Chapman & Hall/CRC, 2002;
11. PETERSEN R.G. - Agricultural Field Experiments. Design and Analysis, CRC Press, 1994;
12. MICLEA M., 1999, Mic lexicon cadastral, Editura Tehnică, Bucureşti.
13. NEUNER J., 2001, Măsurători Terestre-fundamente, Volumul I, Instrumente şi metode de măsurare, Editura Matrix Rom, Bucureşti.
14. NEUNER J., 2000,Sisteme de poziţionare globală, Editura Matrix Rom, Bucureşti.
15 ***. 2003, Calculatoare şi internet, Dicţionar explicativ, Editura Corint, Bucureşti.