

RESEARCH CLIMATE CHANGES – SUNFLOWER HYBRIDS 2018-2020 IN CONSTANTA COUNTY, SOUTH EAST OF DOBROGEA, ROMANIA

Dumitru MANOLE¹, Ana Maria GIUMBA², Laurențiu Luca GANEA³

Abstract. *The experimental field was placed in Amzacea, Constanta County at S.C. SPORT AGRA S.R.L., Center of Development, on the highway 38, 20 km. far from Bulgarian border. Constanta County had the largest weight regarding the surface cultivated in Romania with sunflower crop between 10-12%. The most drought area in Romania is Dobrogea (average 1961-1990: 464 mm rainfall). Climatic change in recent years has accentuated this tendency. The number of hybrids taken into account in our experiment were fifteen in 2018 and twenty in 2020. Genesis has been planted in two periods of the time in 2020. When the planting was delayed the yield was decreased by 303 kg/ha. The aim of this study was: (i) the behaviour of the hybrids in the unbelievable dry conditions, (ii) to see the yield and the behaviour of sunflower hybrids to the attack of main pathogens - *Sclerotinia sclerotiorum*, *Phomopsis helianthi*, *Orobanche cumana*, (iii) how the planting date influenced the yield, (iv) the importance of the pesticides used and (v) economical data.*

Keywords: sunflower, technological improvement, pest behaviour, yield, drought

1. Introduction

Constanta County (Dobrogea area) had the largest weight regarding the surface cultivated in Romania with sunflower crop 19.6% in 2018 [10] and, 11.10% from arable land in 2020 - 20.63% from arable land Constanta area [4].

Nowadays there is a wide offer for sunflower hybrids which means without a screening of them is hard to decide which are the most suitable for every region. It should exist experimental fields not only for sunflower but for other important crops related to a specific region. The hybrids must be from different seed companies eliminating any suspicions. In Dobrogea such experiments were made over the years by [5, 7, 8, 9] who provided results for yield, behavior to the attack of the main pathogens and quality indices, including period of the planting.

The aim of this study was (i) *the behaviour of the hybrids in the unbelievable dry conditions*, (ii) *to see the yield and the behaviour of sunflower hybrids to the*

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attack of main pathogens - Sclerotinia sclerotiorum, Phomopsis helianthi, Orobanche cumana, (iii) how the planting date influence de yield, (iv) the importance of the pesticides used, and (v) economical data.

2. Materials and Methods

The experimental plots were organised in 2018 and 2020 in the field belongs to SC SPORT AGRA SRL Amzacea, Constanta County (South-East of Romania) (Figure 1),(Figure 2). The number of hybrids taken into account were fifteen in 2018 and twenty in 2020. The soil it's a cambic chernoziom with a deeper profile than other chernozioms, a blackish-brown soil of 40-50 cm thickness, medium texture [2]. The content of nutrients are: mobile P index -72; N index -4; K index -200; humus -3.11%; neutral pH -7.2. The area of each plot in 2018 was 560 m², and 670 m² in 2020. The proceeding crop was winter wheat. Planting date was April 11th in 2018 and March 12th in 2020. The depth of planting was 5-6 cm. in 2018, and 8 cm. in 2020 considering the moisture of the soil.



Fig. 1. Experimental field of SC SPORT AGRA SRL Amzacea, Constanta County, 2018 (Original)



Fig. 2. Experimental field of SC SPORT AGRA SRL Amzacea, Constanta County, 2020 (Original)

The seeds have been treated against (i) *Botrytis* and *Sclerotinia* phytopathogens using Maxim 025 FS (fludioxonil 25g/l) at 0.6 l/100 kg, (ii) *Plasmopara helianthi* using Apron XL (metalaxil 339 g/l) at 3 l/t.(iii), and to protect the seeds against Agriotes spp., Tanymecus dilaticolis Gyll. using Cruiser 350 FS (350 g/l tiametoxam) at 10 lt/t in 2018. In 2020 we didn't treat the seeds before planting with neonicotinoids (iii) Tanymecus dilaticollis Gyll., in this case we have used after emergence of the crop insecticides two times.

To control weeds, the herbicides used were: glyphosate, autumn application, in a dose of 2 l/ha, Frontier Forte (dimetenamid-P) in a dose of 1.4 l/ha, Racer 25EC (fluorocloridon) in a dose of 2 l/ha, mixed up before emergence and Pulsar Plus (25g/l imazamox) in a dose of 2 l/ha (used only for the imazamox rezistant hybrids), at 6-8 leaves. Sulfonylurea has been applied for the hybrids resistant to the herbicides tribenurom methyl 30g/ha.

Two fungicides were used in vegetative season, to control the pathogens: Mirage 45EC (procloraz 45%) - 1 l/ha 8-10 leaves, and Pictor (200g/l dimoxistrobin + 200g/l boscalid) - 0.5 l/ha before flowering.

In 2018 the soil was fertilized using two complex fertilizers: 10.20.0 + 20 SO₃ (of which 2N organic) - 300 kg/ha and 40.0.0+13 SO₃ -150 kg/ha. Foliar fertilizers were performed using two complex fertilizers: 12.60.0 - 2 kg/ha and 145 SO₃, 5 MgO, 100 B, 2 Cu, 25 Fe, 50 Mn, 0.5 Mo, 20 Zn - 2 kg/ha, and in 2020 the soil was fertilized using complex fertilizers (18.46.0 + 20 SO₃) 200 kg/ha and nitrogen in vegetation two trips using 150 kg/ha, and second fertilizer 100 kg/ha.



Fig. 3. Planting 2020 (Original)



Fig. 4. Temperature of the soil in the moment of planting 2020
(Original)



Fig. 5. Experimental field in 2020
(Original)

Phytopathological assessments of plants were performed on August 7th in 2018 and on July 17th in 2020 over the main pathogens: *Phomopsis helianthi* Munt.-Cvet. et al., *Sclerotinia sclerotiorum* (Lib.) de Bary, *Alternaria helianthi* (Hansf.) Tubaki & Nishihara and the parasite *Orobanche cumana* Wallr.. The degree of attack (DA%) was calculated using formula $F \times I/100$ (F - frequency of the attacked organs, I - intensity of organs attack).



Fig. 6. *Orobanche cumana*, Onestar 2020.
(Original)

Technological sheet includes data about number of plants/m² after emergence, flowering and harvesting date and the yield at 9% moisture kg/ha.

Rainfall during 2018 and 2020 in Amzacea, reveal that, the last year was real dry, 2020 was the driest year at the time has been with 133 mm. rainfall during the growing season compared with 2018 when the rainfall sum was 569 mm (Table 1).

Table 1. Rainfall during 2018 and 2020 growing season of sunflower (Amzacea, Constanta)

	Month								Sum
	Jan.	Feb.	March	Apr	May	June	July	Aug.	
Days	The growing season 2018: Rainfall (mm) for 10-day periods								Sum
1-10	0	9	6	2	64	35	98	0	214
11-20	44	31	37	0	28	0	2	0	142
21-31	19	80	26	0	0	41	47	0	213
Sum	63	120	69	2	92	76	147	0	569
Days	The growing season 2020: Rainfall (mm) for 10-day periods								Sum
1-10	0	20	0	0	18	4	29	2	73
11-20	0	0	0	4	0	10	0	0	14
21-31	2	8	16	6	14	0	0	0	46
Sum	2	28	16	10	32	14	29	2	133
Days	Average 1961-1990: monthly values of rainfall (mm)								Sum
1-31	27.7	24.0	29.1	31.8	37.7	47.1	38.9	37.4	273.7



Fig. 7. The height of the hybrids 2020 (Original)



Fig. 8. The height of the hybrids 2020 (Original)

3. Results and Discussions

The diseases can affect the yield and hybrids presented a DA greater or less due to their resistance linked with the climatic conditions. Of all tested hybrids, six of them were monitored in both years (Genesis, Janis, Loris, Diamantis, P64LE99 and P64LE25).

In 2018, the greatest DA was attributed to *Alternaria helianthi*, with an average of 21.7%. The lowest attack was to *Orobanche cumana*, where DA was under 1% for all hybrids.

Among hybrids Suria was the most susceptible hybrid to *Phomopsis helianthi*, *Alternaria helianthi*, *Orobanche cumana* with a DA of 35,75%, 45% and 0,2% respectively (Table 2).

Table 2. Phytosanitary status (DA%) – August 7, 2018

Hybrid	Pathogen			Parasite
	<i>Sclerotinia sclerotiorum</i>	<i>Phomopsis helianthi</i>	<i>Alternaria helianthi</i>	<i>Orobanche cumana</i>
Suria	1	35.75	45	0.2
Genesis	0	3	26	0
Janis	8	13.5	40	0
Loris	5	16.5	26	0
Electric	2	8	15	0
Diamantis	1	6	13.75	0,1
Neostar	0	3.75	15.75	0.18
Bacardi	0	9	28	0.2
Gracia	0	8	12	0
5555	5	11	25.5	0
56635	0	13.5	25.5	0
59580	3	8	18	0
P64LE25	2	7	14	0
P64LE99	0	7	9	0
P64LL125	0	5.25	12	0

The very dry conditions of the year 2020 has affected the height of the hibryds between 70 cm (FD15E27, Genesis) to 105 cm.(P64LE25, P64LE99). The diseases can affect the yield and hybrids presented a DA greater or less due to their resistance linked with the climatic conditions.

In 2020 the attack of *Sclerotinia sclerotiorum* all of twenty hybrids were'nt been affected. *Phomopsis helianthi* and *Orobanche Cumana* had a lower DA average.

ES Genesis CL 2 and SY NX82214 (Onestar) CLP had a great DA average for pathogens and parasite combined (8.12% - 7%) (Table 3).

Table 3. Phytosanitary status (DA%) – July 17, 2020

Hybrid	Pathogen			Parasite
	<i>Sclerotinia sclerotiorum</i>	<i>Phomopsis helianthi</i>	<i>Alternaria helianthi</i>	<i>Orobanche cumana</i>
<i>ES Genesis CL</i>	0	8	10	1
<i>ES Genesis CL 2</i>	0	10	20	2.5
<i>ES Janis CL</i>	0	5	12	0
<i>ES Anthemis CLP</i>	0	10	8	0
<i>ES Terramis CL</i>	0	12	15	0
<i>Loris CLP</i>	0	8	10	0
<i>Coloris CL</i>	0	10	6	0
<i>SY Odessa CLP</i>	0	8	0	0
<i>SY Diamantis CL</i>	0	11	0	0

<i>SY NX82212 (Nexus) CLP</i>	0	12	8	0
<i>SY NX82214 (Onestar) CLP</i>	0	20	8	2
<i>RGT Absollute CL</i>	0	12	14	0
<i>RGT Eiffell CL</i>	0	16	10	0
<i>FD15CL44</i>	0	10	8	2.5
<i>ES Aromatic SU</i>	0	0	2	3
<i>SY NX81220 SU</i>	0	15.5	12	0
<i>P65LE99</i>	0	6	10	0
<i>P64LE25</i>	0	2	8	0
<i>P64LE137</i>	0	8	10.5	0
<i>FD15E27</i>	0	10	7	0
<i>FD18E41</i>	0	8	12	0.2

Table 4. Technological sheet for sunflower - 2018

Hybrid	No. of plants/m ² after emergence	Flowering date	Harvesting date	Yield at 9% moisture (kg/ha)
Suria	6	June 22	August 16	2,709
Genesis	6	June 17	August 16	5,038
Janis	6	June 17	August 16	4,562
Loris	6	June 21	August 16	4,054
Electric	6.5	June 19	August 16	4,638
Diamantis	6	June 19	August 16	4,805
Neostar	6.5	June 17	August 16	4,364
Bacardi	6	June 18	August 16	4,475
Gracia	7	June 19	August 16	4,003
LG5555	6	June 16	August 16	4,827
LG56635	6	June 18	August 16	3,674
LG59580	6.5	June 16	August 16	3,834
P64LE25	6.5	June 20	August 16	4,322
P64LE99	7	June 21	August 16	4,425
P64LE125	6	June 22	August 16	4,508

All the hybrids tested had over 6 plants/m² after emergence which means a good and uniform emergence. The average yield in 2018 of the tested hybrids was 4,282 kg/ha (Table 4) exceeding the National average yield of 2018, 2,805 kg/ha reported by the NIS 2019.

Majority of the area cultivated with sunflower in 2020 have been destroyed of the unbelievable dry conditions with an average yield around 778 kg/ha [4]. The best hybrid from those twenty hybrids which have been tested in the experimental field was FD15E27 with 1,914 kg/ha, belongs to National Agricultural Research and Development Fundulea, Romania, followed by P64LE25 with 1,779 kg/ha.

Except Genesis 2 all the hybrids had over 6 plants/m² after emergence. Flowering date was different due their genetic hybrids. Considering the hybrids, all of them had a yield lower than the other years because this year was unforgettable looking to the very dry conditions.

Table 5. Technological sheet for sunflower - 2020

Hybrid	No. of plants/m ² after emergence	Flowering date	Harvesting date	Yield at 9% moisture (kg/ha)
<i>ES Genesis CL</i>	6.5	June 21	August 11	1,593
<i>ES Genesis CL 2</i>	5.5	July 8	August 18	1,290
<i>ES Janis CL</i>	6.5	June 25	August 11	1,428
<i>ES Anthemis CLP</i>	6.5	June 25	August 11	1,774
<i>ES Terramis CL</i>	6.5	June 28	August 11	1,555
<i>Loris CLP</i>	6.5	June 29	August 18	1,420
<i>Coloris CL</i>	6.5	July 2	August 18	1,514
<i>SY Odessa CLP</i>	6	June 25	August 18	1,357
<i>SY Diamantis CL</i>	6.5	June 27	August 18	1,415
<i>SY NX82212 (Nexus) CLP</i>	6.5	June 25	August 11	1,345
<i>SY NX82214 (Onestar) CLP</i>	6	June 25	August 11	1,227
<i>RGT Absollute CL</i>	6.5	July 2	August 11	1,565
<i>RGT Eiffell CL</i>	6.5	July 2	August 18	1,341
<i>FD15CL44</i>	6.5	June 29	August 18	1,343
<i>ES Aromatic SU</i>	6.5	June 26	August 11	1,617
<i>SY NX81220 SU</i>	6.5	June 20	August 11	1,432
<i>P65LE99</i>	6.5	June 29	August 18	1,537
<i>P64LE25</i>	6.5	June 29	August 18	1,779
<i>P64LE137</i>	6.5	June 29	August 11	1,745
<i>FD15E27</i>	6.5	July 2	August 18	1,914
<i>FD18E41</i>	6.5	July 2	August 18	1,375

In 2020, when Genesis was planted with a delay of 22 days the yield has decreased with almost 303 kg/ha (Table 5). Same results were recorded in literature showed a higher duration for seed maturity increases yield in sunflower crop [6, 1, 2].



Fig. 9. Harvesting day 2020
(Original)



Fig. 10. Harvesting day 2020
(Original)

Conclusions

(1) In 2018, Suria was the most susceptible hybrid to *Phomopsis helianthi*, *Alternaria helianthi*, *Orobanche cumana*, while in 2020 Aromatic had a higher attack of *Orobanche cumana*, Genesis 2 the highest average of DA for *Alternaria helianthi*, Onestar to *Phomopsis helianthi*.

(2) Considering the hybrids cultivated in both years, all of them had a yield greater in 2018 due to climatic conditions. When the planting was delayed in 2020 the yield has been decreased with over 303 kg/ha.

(3) In 2020 the area cultivated with sunflower crop in Constanta County was 100.915 ha, but harvested area was 85.720 ha with an average yield per ha 660 kg/ha(General Direction of Agriculture). In 2018 the area cultivated with sunflower crop was 95,110 ha with an average yield/ha 3,512 kg.ha.

(4)The revenue per ha in 2018 was 981.7 Euro (4.65 RON/1 Euro) (FCR), while in 2020 the revenue per ha was 209 Euro (4.83 RON/1 Euro)(FCR) at August 25th. Price per tone in August 25th – 279.56 Euro (Argus Constanta).

(5)On the other hand Constanta County needs irigations, considering the normal climatic conditions of the year 2018.

REFERENCES

- [1] Ahmed, B., Sultana, M., Zaman, J., Paul, S.K., Rahman, Md. M., Islam, Md. R., Majumdar, F., Effect of sowing dates on the yield of sunflower. In: Bangladesh Agronomy Journal, Vol. 18, no. 1, p. 1-5. (2015).
- [2] Demeter, T., General Soil Science (Pedologie generala), Credis Publishing House, Bucharest, 174 (2009).
- [3] Demir, I., The effects of sowing date on growth, seed yield and oil content of sunflower (*Helianthus annuus* L.) cultivars under rainfed conditions. In: Fresenius Environmental Bulletin, Vol. 28, no. 9, pp. 6849-6857. (2019).
- [4] General Division of Agriculture and Development, Constanta, 2020.
- [5] Jinga, V., Dudoiu, R., Lupu, C., Research regarding the improvement of sunflower crop technology in South - Eastern Dobrogea in the context of current climate changes. In: Romanian Journal for Plant Protection, Vol. 9, pp. 15-21 (2016).
- [6] Jonhson, B. J., Jellum, M.D., Effect of planting date on sunflower yield, oil and plant characteristics. In: Agronomy Journal Abstract, Vol. 64, no 6, p. 747-748 (1972).
- [7] Manole, D., Giumba, A.M., Jinga, V., Radu, I., The behavior of new barley and wheat varieties at S.C. Sport Agra-Amzacea, under 2018 conditions. Romanian Journal for Plant Protection, Vol. 11, pp. 39-43 (2018a).
- [8] Manole, D., Jinga, V., Giumba, A.M., Dudoiu, R., Cristea, S., Researches regarding new and improved technologies for sunflower and sorghum crops in the context of climate changes in Dobrogea region. In: Sciendo, Vol. 1, no. 1., pp. 79-85 (2018b).
- [9] Manole, D., Jinga, V., Grădila, M., Radu, I., New edition on sunflower crop - Romanian technology under climate change conditions in Dobrogea. In: Scientific Papers. Series A. Agronomy, Vol. 62, no. 1, pp. 348-354 (2019).
- [10] National Institute of Statistics (2019).

AVOIDING FAILURE IN THE URBAN-RURAL RELATIONSHIP, WITH ROMANIAN SOCIETAL CONNOTATIONS

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Abstract. *Contemporary society has been undergoing major upheavals in recent decades, especially in terms of demographic dynamics in the urban-rural and rural-urban directions. Scenarios and solutions are far from being validated, so that general analyses and consequences at local level become more than timely. This includes the direction of national rural development as a component of the international and global integration process. Elements of the rural, continuously shrinking area and demography are addressed, but which has the potential to become an important necessity and not a derisory annex of the urban. The paper seeks to highlight a number of possibilities, principles and measures to support the increased attractiveness of the Romanian countryside and, by extension, its contribution to the development of agri-food and Responsible Tourism, with a view to 2050.*

Keywords: demography, development, rural, societal, urban

1. Introduction

For the first time in the history of mankind, more people live in cities than in rural areas. The best example is Europe, which is one of the most urbanised continents. Here around 75% of the population lives in urban areas. Moreover, short-term forecasts suggest that the proportion will soon reach 80% [13]. Gradually the whole Earth will become virtually Planet of the Townspeople.

As a result, the relationship between urban and rural is changing as demand for land in and around cities becomes acute. As a consequence, urban sprawl is reshaping the landscape and in many ways affecting people's quality of life and the environment more than ever before. Urban planning and management are therefore high on the public agenda, with transport and housing being crucial challenges. In this context the urban-rural relationship highlights that urban development directly influences rural structure and functionality through a number of external factors such as demographic change, the need for mobility, globalisation and climate change.

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The study is based on the hypothesis that, starting from the idea that Romanian societal development is directly linked to socio-economic elements, georesources, demographic evolution and cultural specificity, and taking into account this complexity, the relationship between urban and rural is in fact unbalanced, which requires a harmonization of theoretical and practical nature. In this sense, the aim of the paper is to make a principle analysis contributing to the establishment of theoretical, practical and information strategy elements for the sustainable and optimized development of the "urban - rural" relationship at the societal level, with applicability to the specific Romanian society. The focused objective of the paper is to develop the necessary concept for a harmonized strategy on the future development of the urban-rural relationship in our country and to avoid a failure in the development of the Romanian countryside.

2. Materials and Methods

The study is based on a demographic diagnosis with a focus on the socio-economic aspects of the Romanian rural environment and on a series of multi-criteria analyses, comparisons and statistical processing. The principles, techniques and regulations specific to sustainable development are considered.

3. Results and Discussions

The Data processing for finding solutions to achieve the proposed objectives is done by analyzing the flows of the urban-rural relationship directed on three dimensions: - analysis of demographic dynamics in the world and in Romania, with emphasis on the population in rural areas; - analysis of economic dynamics specific to the urban and rural environment; - establishment of principles in future strategies necessary to avoid failure in the development of the urban-rural relationship in Romanian society (Fig.1).



Fig. 1. Two-way relationship between urban and rural development

3.1. Analysis of demographic dynamics

Today, 54% of the world's total population - 7.046 billion people - live in cities, more than 5.2 times the number who lived in urban areas 60 years ago, according to the United Nations (UN). Estimates predict that the number of people living in cities will increase by a further 2.5 billion by 2050, the UN says in the revised edition of the World Urbanisation Report [10, 11], as shown in Figure 2 [14].

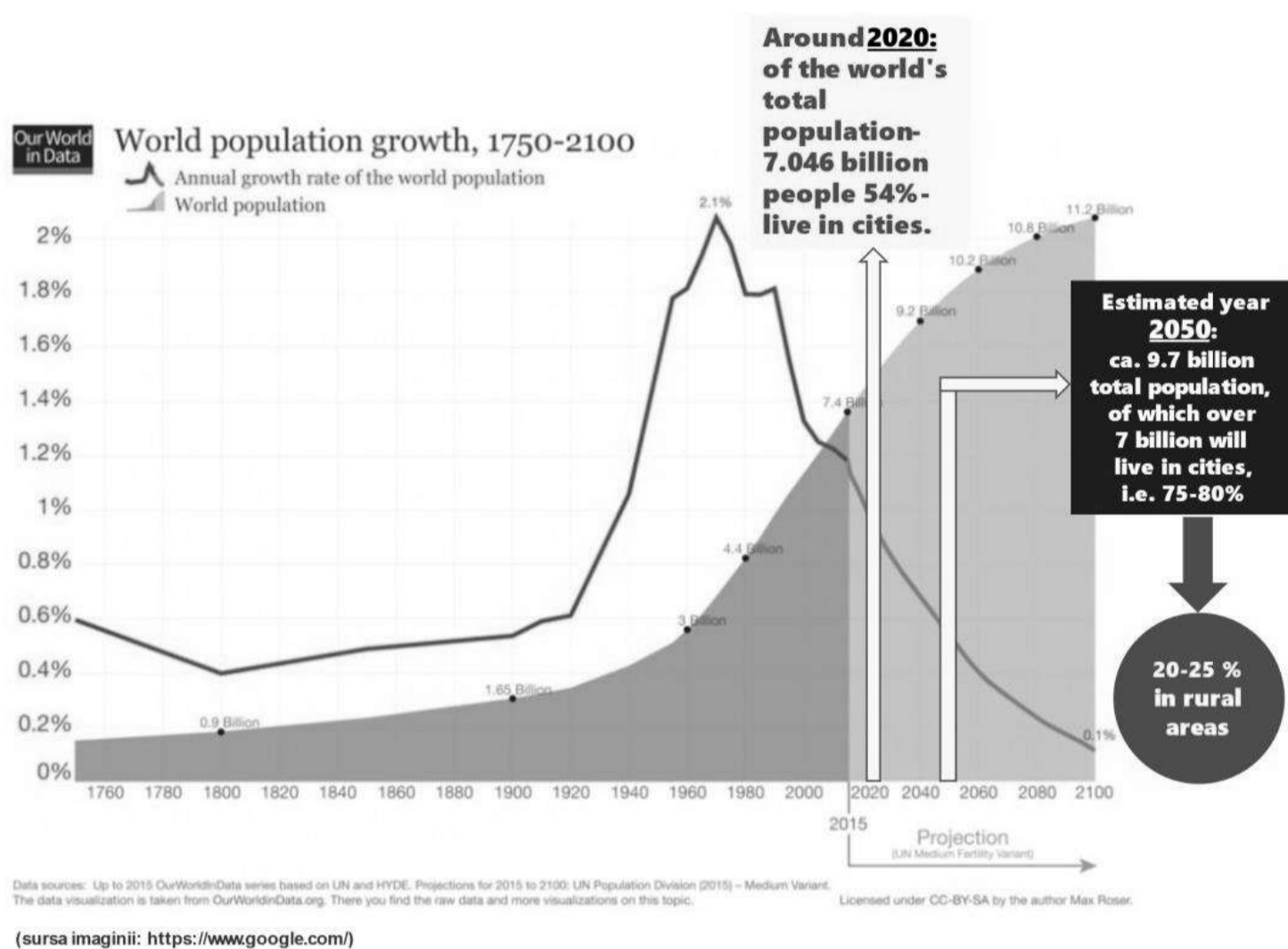
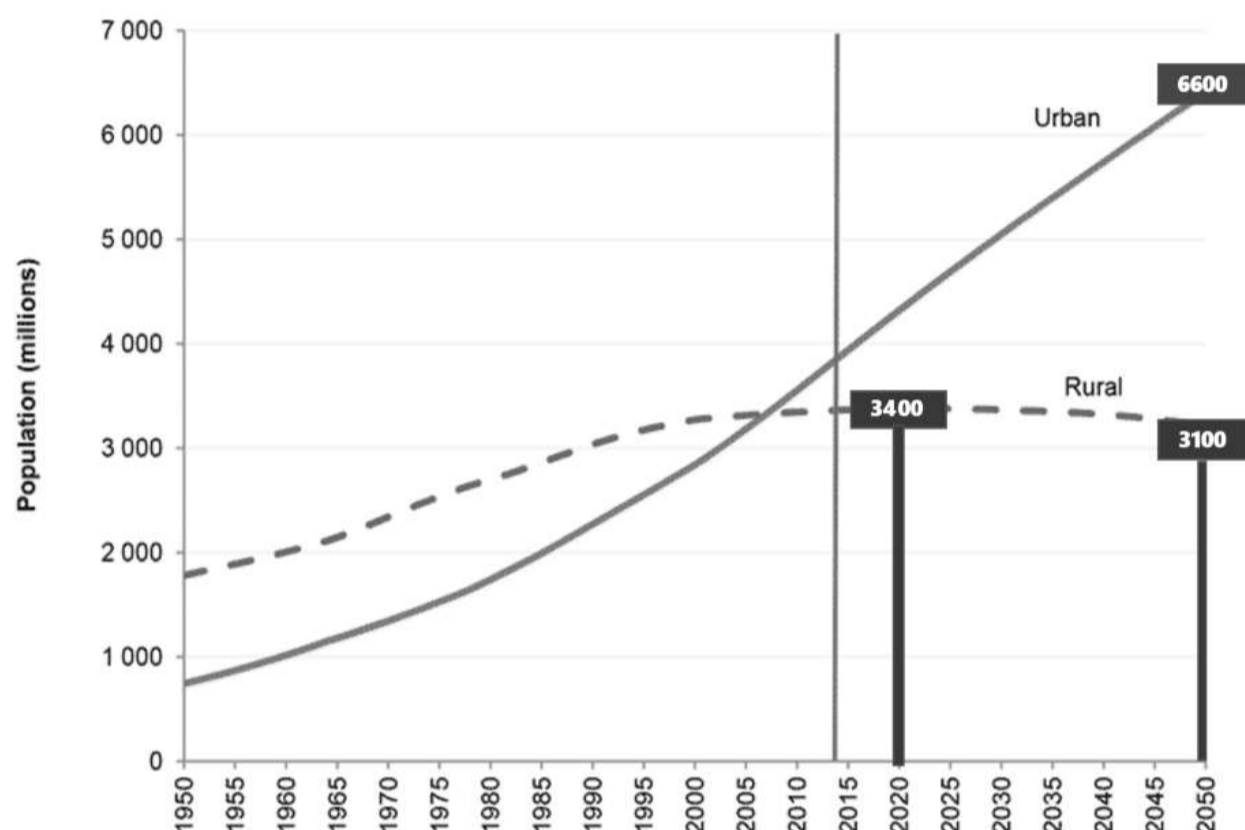


Fig. 2. Population dynamics in the world

Factors influencing population dynamics are life expectancy, fertility rates, urbanisation and migration. It is clear that the countryside is shrinking (Figure 3), but at the same time it is becoming increasingly important from a socio-economic perspective on the basis of its profile, which will be sought by more and more people living in urban agglomerations [3].

In Europe, it is estimated that some countries will lose even more than 15% of their population by 2050, and Romania is one of them [5, 6], with the urban-rural ratio illustrated in Figure 3.

RATIO OF URBAN TO RURAL POPULATION WORLDWIDE



Around 2020 the GLOBAL RURAL POPULATION reached 3.4 billion people (i.e. 48.25%) and will most likely decrease to 3.1 billion in 2050.

(source - <https://www.google.com/>)

Fig. 3. Declining rural population

Romania is certainly part of this global trend, but it is appropriate to see the nuances of its evolution within this general trend in order to avoid certain errors recorded in other countries.

The Romanian population decline can be analysed from various points of view [2, 8, 6]. Basically, we can refer to **active decline**, which is considered to be that generated or maintained mainly by external migration, but usually combined with **demographic decline**, i.e. that inherited and caused by the age group structure and natural population decline. In general, and for our country in particular, a distinction is also made between active decline caused by *internal rural-urban* (or *intra-regional*) migration and *external migration* (between European countries or intercontinental). Unfortunately, the exaggerated emigration in Romania over the last three decades illustrates the lamentable failure of the policy and governance applied, which has NOT provided sufficient economic and social opportunities at national level, but also at the level of the urban-rural relationship.

From the data published by the National Institute of Statistics [5,6] we can see that the population (by residence) was 22.089 million people on 1 January 2021 (down 0.5% from the previous year), of which the population by residence in urban areas was 12.442 million people and 9.647 million in rural areas, i.e. 43.67% (Fig. 4).

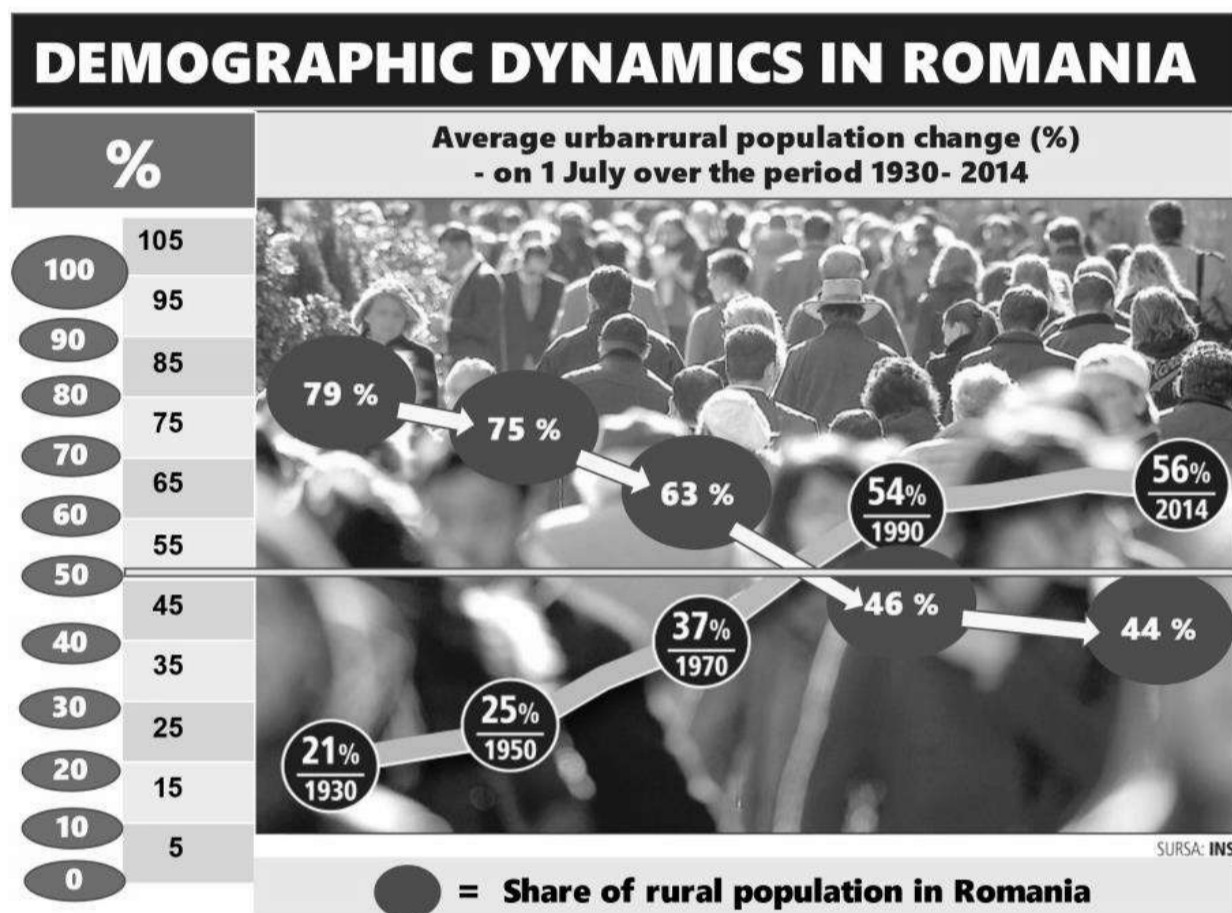


Fig. 4. Evolution of the Romanian urban and rural population over the last 100 years

In the urban-rural relationship it can be seen that in recent decades the Romanian economy has been increasingly divided into two distinct parts, defined by the residential criterion, respectively: a growing *urban Romania*, with a strong liberal component, which expects from the state opportunities rather than support, and a conservative *rural Romania*, with older people (usually over 60-65 years old), as well as people below the poverty line, who need help, not only for household development, but especially for survival [1, 7]. The young rural population has emigrated en masse, both to urban areas and especially to EU countries.

Within this pattern it is noticeable that the support of progress is provided by the URBAN ENVIRONMENT which largely influences our technological,

educational, intellectual and cultural achievements and innovations, and lately a greater adaptation to societal demands can be observed.

On the other hand the existing model of urban-rural relationship has many shortcomings, so the current trend in urban development is moving towards REDUCED URBAN DENSITY approaches. This is because 'urban' leads to increased consumption of energy, resources, transport and land, increasing greenhouse gas emissions and air and noise pollution to levels that often exceed recommended (and legal) human safety limits.

There are also, in our view, shortcomings at the individual level: - overall consumption, energy use, water use and waste production, differentiated taxes and charges are all increasingly common and growing in many urban dwellings.

3.2. Analysis of economic dynamics specific to the urban-rural relationship

Rural decline is an inevitable process, generated by the perpetual transition of human society, generally with net positive benefits, from one societal model to another (Fig. 5), but it is essential how this transition is made in order to avoid a partial or even total failure, not only economic, but also cultural.

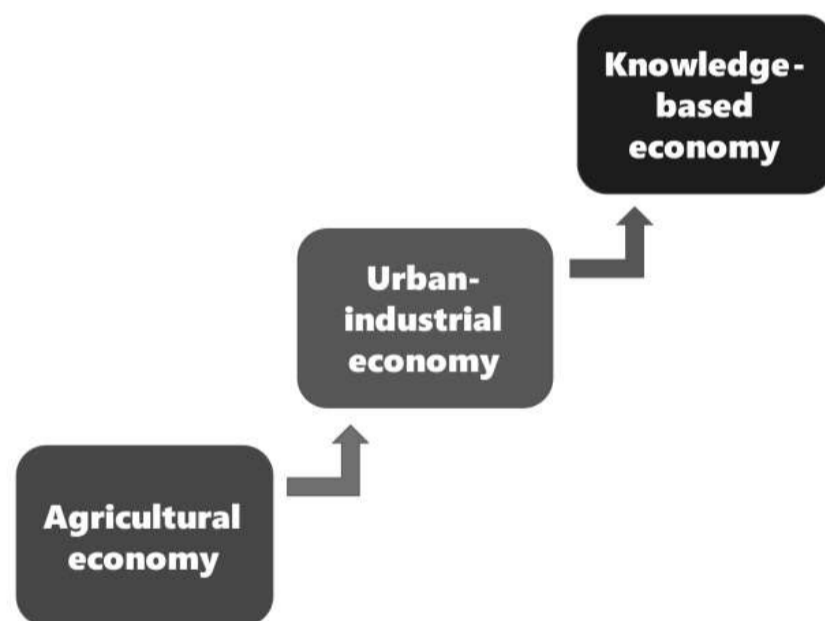


Fig. 5. Socio-demographic transition based on economic typology

In order to avoid the failure of the unbalanced relationship between urban and rural, at least two basic aspects can be considered: (a) The elaboration of harmonized development strategies between an integrated and subsidized rural economy, by an urban economy, beneficiary of the new ecological and organic quality products; (b) Societal development based on public policies supporting the process of definitive settlement in rural areas directly linked to the rural citizen's **purchasing power**.

As the expansion of urban areas has occurred mainly on former agricultural land, it has resulted in the loss of important ecosystem services [3], such as: food production; flood protection; biological diversity.

The principled rebalancing of the urban-rural model is about rethinking the position of 'the rural' [12]. Thus we can anticipate that the rural environment has the potential to be a significant quality of life priority for Romania. In this context, a first step is to REDEFINE RURALITY in the sense that, as already suggested, it must be realised that a "quantitatively" reduced rural area becomes a "qualitatively" valuable area by increasing its socio-economic and info-cultural importance, in the context of the needs and desires of townspeople. Three directions are essential in the sense of what has been said: - physical and mental reinvigoration of the body during holidays (*health*); - reconnecting with environment, with landscapes, flora and fauna (*Nature*); - reconnecting younger generations with the "ancestral original", reoriented and repositioned in the specific urban environment (*education*).

The next step is to IMPLEMENT INTELLIGENT PUBLIC POLICIES. Therefore, action must be taken to "polish the diamond" represented by the rural space and spirit in order to avoid the failure of other countries to transform the rural into a smaller urban, with the loss of the specific natural landscape, the customs and traditions of the authentic village, and in some cases, the traditional economic attractiveness. To AVOID THE FAILURE OF DEVELOPMENT IN THE URBAN-RURAL RELATIONSHIP we analyse both the regional decline [4,12] which can be assessed by 8 significant dimensions (Fig.6).

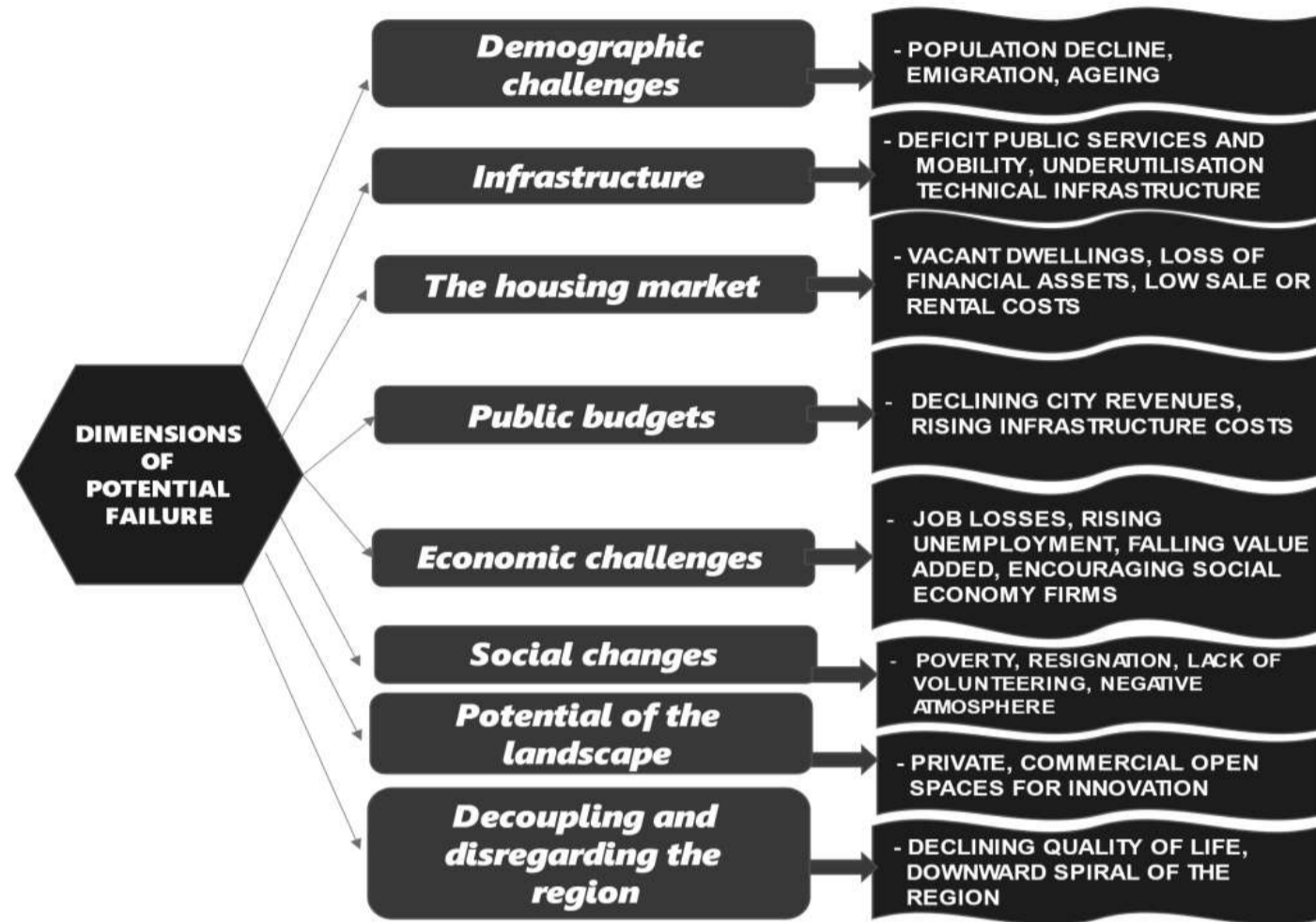


Fig. 6. Benchmarks for avoiding urban-rural failure at regional level

However, Romania is a special case where rural depopulation is not taking place in favour of internal urbanisation, but of international migration. Four categories of complex decline are usually identified [1] (these can coexist and interact in the same region) depending on the causes (Fig. 7).

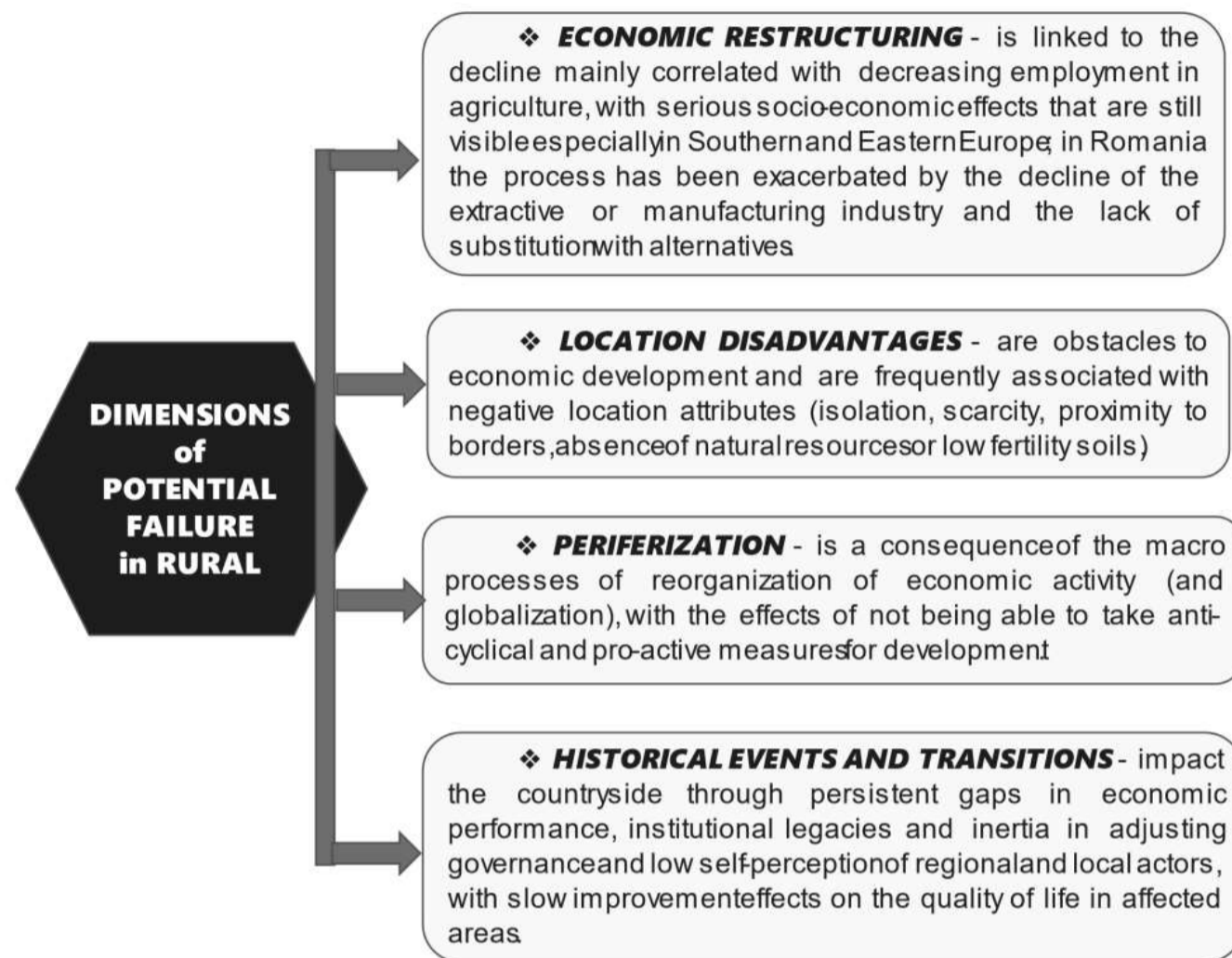


Fig. 7. Benchmarks for avoiding urban-rural failure at local level, including rural

The socio-demographic and economic diagnosis highlights not only the complexity of the urban-rural relationship as a development of human society, but especially the factors that need to be adapted and harmonized in order to avoid a failed transition.

3.3. Analysis of the establishment of principles to avoid the failure of the urban-rural relationship

We have in mind two contradictory elements that can generate various disharmonies, namely: on the one hand the number of people in rural areas is decreasing, and on the other hand the fact that rural areas occupy 87% of the national territory [9]. Also, analyzing the specific aspects of rural decline, we note that the Romanian rural environment is characterized by a strong social and economic heterogeneity between the different areas of the country, which is also reflected in the demographic evolution.

Therefore, rural localities located in peri-urban or tourist areas show positive demographic trends, mainly due to urban-rural migration. In comparison, isolated settlements, or those more than 30 km from various urban centres, show negative demographic trends, even with deserted areas (villages).

The evolution of the rural population follows the socio-economic evolution of rural communities, which has a decisive influence on migration. We refer to a number of aspects such as the level of development achieved by localities, infrastructure and public services, distance to larger urban centres, all of which are basically indicative of the living conditions that a given rural locality entails.

The disharmonies of societal development in the urban-rural spectrum have led to changes in the rural population over the last two decades. They are evidenced by the negative evolution of the main demographic indicators, which has generated a pronounced demographic imbalance manifested by an ageing population, falling birth rates and fertility, rising mortality rates, but also by the explosion of external migration, with the main negative effect being the depopulation of rural areas, especially those in fragile areas (upland, wetland and deepwater areas).

Without drastic economic and social policy corrections, the National Institute of Statistics estimates, as a plausible variant, that the evolution of the Romanian resident population in rural areas will be 6,141,500 inhabitants by 2060, representing a decrease of 2,930,700 people or 32.3% between 2017 and 2060 [6].

Rural demographic decline as a failure of the urban-rural relationship is the result of the combined action of several factors. These include: - dependence on subsistence farming/ - low incomes of farmers and workers in agriculture (compared to other sectors)/ - lack of opportunities for small business development/ - low level of development of basic infrastructure and public services / - poor quality of connective infrastructure (which can limit commuting)/ - location of villages in areas affected by natural constraints, characterized by low land productivity, especially in mountainous areas, etc.

The very serious effect is the abandonment of agricultural activities in favour of other types of activity in urban areas, with soil and biological degradation of the land, a situation that is difficult to remedy in the future.

It is becoming timely to develop societal strategies for urban-rural relations based on scientific knowledge and objective and ethical principles. In this respect, the complexity of future strategies for the development of the urban-rural relationship should refer to an integrated structure of strategic elements, which should contain at least four complementary strategic components: - the conceptual component; - the operational component; - the architectural and landscape component; - the political-administrative component based on appropriate public policies.

Public policies for the development of a *balanced and bioharmonised urban-rural relationship* will only be economically efficient and systemically effective

if they give human and other species a chance to live (especially in rural areas we talk about biological harmonisation, i.e. bioharmonisation). This is based on existing expert studies, backed up by hundreds of studies and researches little used in decision-making approaches (!). In principle, it becomes absolutely necessary that SCIENCE is present in the political decision so as to avoid the failure of the urban-rural relationship through the following aspects of the **bioharmonisation process** [6]: (a) Correlation and harmonization between natural resources and geo-political market requirements; (b) Correlation between industry (urban) and agriculture (rural); (c) Correlation between quantity-oriented intensive-industrial and quality-oriented semi-intensive and organic agriculture; (d) Correlation between economic elements and finance; (e) Correlation and avoidance of urban and rural cultural disharmony.

Conclusions

(1) The DEMOGRAPHIC CRISIS in Romania is of great proportions, noting that our country is among the EU countries with the greatest decline in urban areas, while it is forecast that a quarter of Romania's rural population will shrink by 2050 (!).

(2) THE PROBLEM OF RURAL SHRINK is a complex one, which goes beyond the phenomena of depopulation and migration, so that national rural development programmes must explicitly take into account the demographic challenges, including the causes of shrinkage and the disadvantages of location, of elements of peripheralisation, as well as the solution based on the principles of bioharmonisation of the urban-rural relationship based on scientific directions for action.

(3) A FOCUSED RESPONSE on economic restructuring and the importance of rural areas for the implementation of the new European Ecological Pact in Romania is needed, in particular with regard to a just transition by supporting the bioeconomy, initiatives in the direction of the circular economy and the development of sustainable agri-zootechnical production and diversified and high-quality processing of food resources.

(4) In order to avoid urban-rural failure, the DEVELOPMENT OF INTELLIGENT PUBLIC POLICIES and the process of drawing up regional and local *strategies on rural contraction* must be balanced, bioharmonised and substantially strengthened at local level, where it becomes mandatory to empower all actors (both regional and local) with the development and implementation of such policies, especially in the maximum use of European funds.

REFERENCES

- [1] ESPON, European Shrinking Rural Areas Challenges, Actions and Perspectives for Territorial Governance (ESCAPE), <https://www.espon.eu/escape>, Accessed on March, 2022 (2020).
- [2] Gruia,R., Bioarmonism, from Theory to Practice to a future Ideology (In Romanian), Clarion Publishing House, Brasov, pp.27-36, 201-206 (2019).
- [3] Gruia,R., Gaceu,L., Rural Development Sustained by Agri-rural Tourism and the Novelty of the Romanian Village, Annals of the Academy of Romanian Scientists, Series on Agriculture, Silviculture and Veterinary Medicine Sciences, ISSN Online 2344-2085, Vol. 10 Number 1/2021 , 33-40 (2021).
- [4] Küpper, P. et al. Regionale Schrumpfung gestalten, https://literatur.thuenen.de/digbib_extern/dn052553.pdf, Accessed on 30 December 2020 (2013).
- [5] National Institute of Statistics, Projection of Romania's population by residence on 2060 horizon,https://insse.ro/cms/sites/default/files/field/publicatii/proiectarea_populatiei_pe_medii_de_rezidenta_la_orizontul_anului_2060.pdf, Accessed on 30 December 2020 (2019).
- [6] National Institute of Statistics, Social statistics, <http://statistici.insse.ro:8077/tempo-online/>, Accessed on 30 December 2020 (2020).
- [7] Romania's Government, Romania's territorial development strategy: Policentric Romania 2035. (10) Rural areas in decline · MDLPA-DPS. (2017).
- [8] Romania's Government, National Strategic Plan 2021-2027, https://www.madr.ro/docs/dezvoltare-rurala/PAC_dupa_2020/2020/DRAFT-Analiza-SWO-T-Plan-National-Strategic-2021-2027.pdf, Accessed on 30 December 2020. (2020).
- [9] Romania's Parliament, Law 351/2001 concerning the approval of Plan for national territory management - Section IV- Localities network, <http://legislatie.just.ro/Public/DetaliiDocument/29780>, Accessed on 15 March 2022 (2001).
- [10] United Nations, World Population Prospects 2019, <https://population.un.org/wpp/Publications/>, Accessed on 30 December 2020 (2019).
- [11] United Nations, Population, <https://www.un.org/en/sections/issues-depth/population/>, Accessed on 30 December 2020 (2020)
- [12] *** - <https://www.espon.eu/escape>.
- [13] *** - <https://www.eea.europa.eu/ro/themes/urban/about-the-urban-environment>, Accessed on March, 2022.
- [14] *** - <https://www.google.com/>, Accessed on March, 2022.

INTERACTIONS BETWEEN PYRUS PYRASTER TREES (WILD PEAR) AND GRASSLAND IN AN AGROSILVOPASTORAL SYSTEM

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Abstract. *The research is carried out on the Pyrus pyraaster grasslands from Jimbor village commune Homorod, on the floor of the oak forests. Our study makes an analysis of the connections that exist between Pyrus pyraaster trees and grasslands in terms of floral composition, nutritional and pastoral quality of herbaceous layer, analyzes the amount of nutrients in the soil and necessary for plant development and it also evaluates the production of nutrients per hectare, both under the canopy of Pyrus pyraaster trees, as well as in the open field. The number of species found in the herbaceous layer of shady ground is with 22 % larger than in the open field, and the participation of fodder species is 24 % higher under the canopy of trees than in the land in full sun. The most found species under trees is Lolium perenne, it's participation percentaje being almost 4 times higher than in the open field, this influencing the green mass production which is 14 t/ha. The nutritional value of the feed consumed by the animals grazed is very good being supplemented in the autumn months with ripe forest pear fruits.*

Keywords: agrosilvopastoral system, *Pyrus pyraaster*, productivity, biodiversity

1. Introduction

Agroforestry systems include all land uses in which forest species are deliberately maintained or introduced into agricultural production to benefit from the result of their ecological and economic interaction. It is, therefore, a broad concept, which includes all forms of association between trees and/or shrubs, on the one hand, and agricultural crops, grasslands and/or animals, on the other hand [6].

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The main feature of agroforestry systems is that the association of the components that make up their composition (trees, grasslands, animals), is done at the same time and on the same land [2].

Agroforestry and pastoral systems must always be analyzed in two ways. Firstly, in order to obtain additional, diversified and high-quality grass production, in order to ensure ecological stability and secondly, the high economic aspects that these systems can create are taken into account.

Capitalizing on the benefits offered by agroforestry systems can be one of the ways to improve the quality of the environment and conserve natural resources. These systems can maintain the balance and functionality of ecosystems, increase their diversity, reduce the action of greenhouse gases (by storing carbon) and create the most suitable environment for the production of high quality feed, with grazing being carried out in the most efficient way.

For this, we need extensive research on agroforestry systems that still exist in our country, the grassland being the most important component of an agroforestry system, its quality and productivity being directly related to obtaining high quality ecosanogenic animal products.

The trees in the agro-forestry-pastoral systems come from species resistant to frost and drought, to various anthropogenic actions and able to exploit the productive potential of the soil, such as: oaks, sessile oak, beech, cherry, wild pears, etc. [6].

This paper analyzes the interactions between wild pear trees (*Pyrus pyraster*) and grassland, in an agro-silvo-pastoral system, based on the premise that trees in agricultural systems ensure a much more efficient use of light, water and of nutrients, than in general, on grasslands devoid of forest vegetation (Figure 1).

2. Materials and Methods

The researches were carried out in Jimbor village, Homorod commune, Brașov county, on the grasslands grazed with sheep and cows, according to the current pastoral arrangement, Oak Forest, in the altitudinal floor of oaks.

From the point of view of the physical and geographical reasoning, the studied territory falls within the Transylvanian Plateau Land, Homoroadelor Hills district, with small slopes and an average altitude of 620 m.

The field works consisted in delimiting the research perimeter from which a number of 10 woody hairy trees (*Pyrus pyraster*) and 10 open field areas located at approx. two tree heights were chosen (Figure 1).

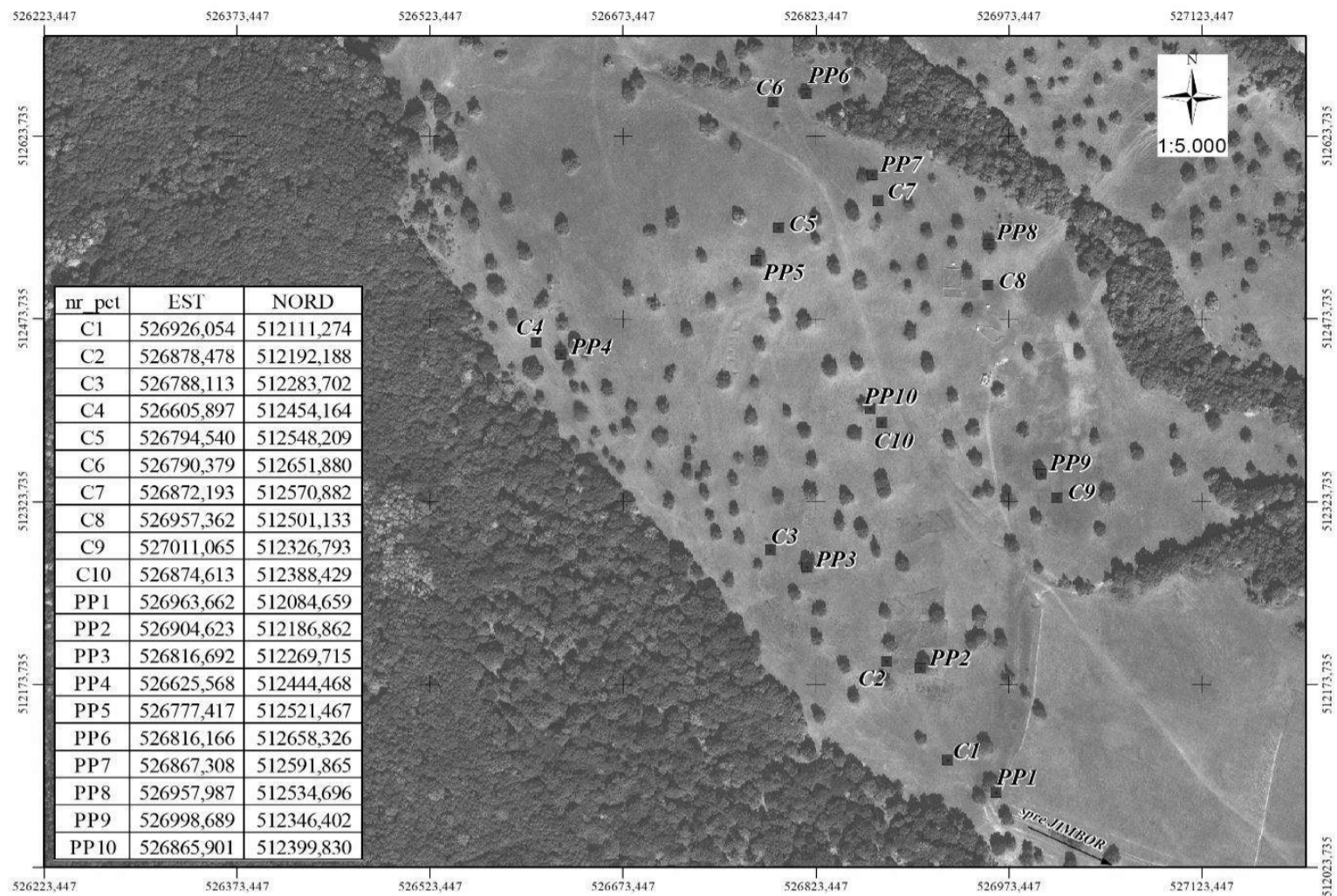


Fig. 1 Satellite image with the projection of the analyzed surveys (Google Earth Pro 2019)

Floristic surveys were carried out under the canopy of forest brushes and in the open field on surfaces of 100 sqm each (Figure 2, 3).



Fig. 2



Fig. 3

Images from the realization of the floristic surveys

Halfway between the edge of the canopy and the trunk of the trees in a circle and on the diagonal of the sample surface (10 x 10 m) of the surveys, soil samples were taken at a depth of 0-10 cm, with an agrochemical probe. Also, in order to determine the quality of the feed consumed by the grazing animals, grass samples were taken.

The soil analyzes were performed by the Office of Pedological and Agrochemical Studies Brașov, and the analyzes of the grass samples, by the quality laboratory of the fodder quality from the Research - Development Institute for Grasslands, Brașov.

Based on the floristic surveys, the productivity of the grass carpet (pastoral value and green mass production), was evaluated according to a new method [4]. In this sense, the floristic surveys were carried out by appreciating directly in percentages the participation of the species (P%) in the grass carpet (Klapp - Ellenberg) in order to be able to continue to perform the calculations on pastoral value (PV), production indices of the species (IM), and consumable green mass (GM t/ha).

The pastoral value (PV) was calculated using the formula: $PV = \sum P (\%) \times F/9$, where F is the feed quality index according to Kovacs (1979), Păcurar and Rotar (2014), and Marușca (2019), [3, 7, 4].

The production of useful phytomass or green mass production (GM) was estimated considering only the species with F4 to F9, by multiplying the P% value with a plant habitus coefficient (M), having values from 1 (very small) to 9 (very high), thus establishing a weighted IM index value [4].

The final evaluation of the GM is made by multiplying the IM habitus index value with other indices values established in grassland experiments [4].

3. Results and Discussions

The soil supply degree with nutrients directly influences the floristic composition of the grasslands studied. Thus, the soil samples analyzed show differences in terms of higher trophicity under trees (shaded ground) than in open field (Table 1).

The results of the analyzed soil samples show that its supply with nutrients necessary for the development of plants (nitrogen, phosphorus, potassium) is 14 to 67% higher in the soil under the canopy of *Pyrus pyraister* trees than in open field soil.

The nutrient richness of the soil in the shaded ground is mainly due to the manure left by the animals that stand in the shade for rest, sawdust or scratched by the tree trunk.

Table 1. Agrochemical values of open field grassland soil and from shady ground

Specification	Unit	1. Open field	2. Shady ground	Diff. 2-1 (+, -)	%
pH in H ₂ O	ind.	5.45	5.95	+0.50	109
Humus	%	6.96	6.96	0	100
Nitrogen index	%	5.08	5.79	+0.71	114
Mobile phosphorus	ppm	5.08	7.5	+2.42	148
Mobile potassium	ppm	240	> 400	> 160	> 167
Amount of exchangeable bases	me/100g	19.0	24.4	+5.4	128
Hydrolytic acidity	me/100g	7.0	4.9	-2.1	70
Cation exchange capacity	me/100g	26.0	29.3	+3.3	113
Base saturation degree	%	73.1	83.3	+10.2	114
Interchangeable aluminum	me/100g	0.067	0	x	x

In addition to this naturally obtained positive aspect, the cattle that stay in the shade of the trees consume the ripe forest pears, later helping to spread the hair seeds through the manure left on the grassland. This later leads to the natural regeneration of grassland with forest pears, the old trees can be removed in favor of the young generation [1].

Quantitative differences between the percentage of participation of each herbaceous species encountered in the analyzed surveys, respectively forage value indices (F) and useful phytomass index (M), used for the calculation of productivity (both qualitative and quantitative) of grassland in the shade of trees of *Pyrus pyrastrer* and open field, are shown in Table 3.

All the changes that take place in the soil and on its surface, obviously influence the development of plants in the herbaceous layer. Thus, we notice that the percentage of participation for the very valuable fodder species, *Lolium perenne*, exceeds in the analyzed surveys under the trees, by approximately 4 times more (390%) the percentage of participation in the open field. Also under trees and with a higher percentage than in the land in full sun, there are other valuable species such as: *Festuca pratensis*, *Phleum pratense*, *Poa pratensis*, *Alopecurus pratensis*, and decreasing by 80-94% compared to open field *Agrostis capillaris* and *Festuca rupicola*.

A very important aspect to emphasize is the presence of nitrophilous species in the composition of the herbaceous layer under the trees, namely: *Urtica dioica* (6.0%), *Sisymbrium officinale* (4.3%), *Erodium cicutarium* (0.7%), *Xanthium spinosum* (0.6%) and others, as a result of overstaying with sheep (Figure 3).

Table 3. Floristic composition and productivity of grasslands from open field (OF) and shaded grasslands (SG) of the 20 surveys

Species	Presence class		Participation %				Indices	
	OF	SG	OF	SG	Diff.+ -	%	F*	M**
Acoperire	x	x	100	97.3	-2.7	97	x	x
Poaceae			63.2	51.9				
<i>Agrostis capillaris</i>	V	IV	15.1	3.2	-11.9	21	7	5
<i>Festuca rupicola</i>	V	I	32.5	1.8	-30.7	6	5	5
<i>Lolium perenne</i>	IV	V	10.6	41.1	+30.5	388	9	8
<i>Cynosurus cristatus</i>	III	III	1.3	1.3	x	100	7	4
<i>Festuca pratensis</i>	III	II	1.1	1.2	+0.1	109	8	9
<i>Deschampsia caespitosa</i>	II	II	0.8	0.8	x	100	3	0
<i>Festuca valesiaca</i>	II	-	1.6	-	x	x	5	3
<i>Anthoxanthum odoratum</i>	I	I	0.1	0.3	+0.2	300	5	3
<i>Phleum pratense</i>	I	I	0.1	0.3	+0.2	300	9	8
<i>Bromus hordeaceus</i>	-	III	-	0.7	x	x	3	0
<i>Poa pratensis</i>	-	II	-	1.1	x	x	8	6
<i>Alopecurus pratensis</i>	-	I	-	0.1	x	x	8	7
Fabaceae			19.6	18.3				
<i>Trifolium repens</i>	V	V	15.3	16.1	+0.8	105	8	5
<i>Trifolium pratense</i>	V	IV	3.4	2.1	-1.3	62	8	7
<i>Lotus corniculatus</i>	III	-	0.9	-	x	x	8	6
<i>Trifolium arvense</i>	-	I	-	0.1	x	x	4	2
Alte familii			17.2	27.1				
<i>Leontodon autumnalis</i>	V	IV	1.8	1.4	-0.4	78	5	3
<i>Achillea millefolium</i>	V	III	2.7	0.6	-2.1	22	6	4
<i>Plantago lanceolata</i>	V	III	1.9	0.8	-1.1	42	6	1
<i>Agrimonia eupatoria</i>	V	II	1.5	0.4	-1.1	27	3	0
<i>Carduus acanthoides</i>	IV	IV	1.4	1.2	-0.2	86	2	0
<i>Fragaria viridis</i>	IV	I	2.3	0.3	-2.0	13	4	1
<i>Daucus carota</i>	III	III	0.5	0.6	+0.1	120	6	5
<i>Potentilla reptans</i>	III	I	0.7	0.2	-0.5	29	3	0
<i>Taraxacum officinale</i>	II	V	0.6	1.8	+1.2	300	7	3
<i>Prunella vulgaris</i>	II	III	0.6	0.7	+0.1	117	4	2
<i>Juncus conglomeratus</i>	II	I	0.5	0.3	-0.2	60	3	0
<i>Alchemilla vulgaris</i>	I	I	0.1	0.2	+0.1	200	6	4
<i>Filago arvensis</i>	I	I	0.2	0.2	x	100	3	0
<i>Cichorium intybus</i>	I	I	0.2	0.1	-0.1	50	5	6
<i>Juncus tenuis</i>	I	I	0.1	0.3	+0.2	300	3	0
<i>Ranunculus repens</i>	I	I	0.1	0.2	+0.1	200	1	0
<i>Mentha longifolia</i>	I	I	0.1	0.1	x	100	4	6
<i>Carex pallescens</i>	II	-	0.5	-	x	x	4	3
<i>Centaurea phrygia</i>	II	-	0.6	-	x	x	4	6
<i>Cirsium vulgare</i>	I	-	0.2	-	x	x	2	0
<i>Eryngium campestre</i>	I	-	0.1	-	x	x	3	0
<i>Galium verum</i>	I	-	0.1	-	x	x	5	4
<i>Gypsophila muralis</i>	I	-	0.1	-	x	x	3	0

Species	Presence class		Participation %				Indices	
	OF	SG	OF	SG	Diff.+ -	%	F*	M**
<i>Lysimachia nummularia</i>	I	-	0.1	-	x	x	3	0
<i>Verbena officinalis</i>	I	-	0.2	-	x	x	4	4
<i>Urtica dioica</i>	-	V	-	6.0	x	x	3	0
<i>Polygonum aviculare</i>	-	IV	-	2.4	x	x	5	3
<i>Sisymbrium officinale</i>	-	IV	-	4.2	x	x	3	0
<i>Erodium cicutarium</i>	-	III	-	0.7	x	x	3	0
<i>Plantago major</i>	-	III	-	0.9	x	x	4	5
<i>Stellaria media</i>	-	II	-	0.6	x	x	1	0
<i>Arctium lapa</i>	-	I	-	0.1	x	x	2	0
<i>Crataegus monogyna</i>	-	I	-	0.1	x	x	3	0
<i>Eleocharis palustris</i>	-	I	-	0.1	x	x	3	0
<i>Geranium pratense</i>	-	I	-	0.1	x	x	3	0
<i>Glecoma hederacea</i>	-	I	-	1.5	x	x	3	0
<i>Malva sylvestris</i>	-	I	-	0.3	x	x	3	0
<i>Rosa canina</i>	-	I	-	0.1	x	x	3	0
<i>Xanthium spinosum</i>	-	I	-	0.6	x	x	2	0
Total specii (nr.)			37	45	+8	122	x	x
din care: - furajere			25	24	-1	96	x	x
- nefurajere			12	21	+9	175	x	x
Participare specii furajere			61.7	76.8	-15.1	124	x	x
Participare specii dăunătoare			38.3	20.5	-17.8	54	x	x
Goluri în vegetație			0	2.7	x	x	x	x
Valoarea pastorală (VP)			67.9	70.3	+2.4	104	x	x
Indice fitomasă utilă (IM)			4.84	5.07	-0.23	105	x	x
Producția de furaj (MV t/ha)			13.07	14.20	-1.13	109	x	x

F* = feed value indices

M** = useful phytomass value indices



Fig. 3. Surface invaded with nitrophilous species

The percentage of participation of forage species is 24% higher under three shade than in open field, and the percentage of harmful species is 46% lower under the protection of the canopy of trees against the ground in full sun.

Given the large number of forage species as a presence (25 in open field and 24 under three shade) of the two types of surveys, there is a very good pastoral value, with values between 67.9 and 70.3. This is also reflected in the continuity of the grass cover, in both situations, the percentage of gaps being very small, even zero in the open field and 2.7% in shady ground, so the grass cover is almost complete.

Green mass production is 13.07 t / ha in open field and 14.20 t / ha in shaded land, about 9% higher in the second case.

Finally, we can talk about the quality of grass under three shade and in open field, analyzing its main chemical parameters: crude protein (PB), fibrous fractions (NDF, ADF and ADL) and digestibility (DSU, BMD). All these elements determine the nutritional value of the fodder consumed by the animals grazed in the agrosilvopastoral system with wild pears (Table 4).

The crude protein (CP) of the treeless grassland reaches 17.7% and grows slightly over 22% under the wild pears. Likewise, the digestibility of dry matter (DDM) and organic matter (DOM) increases under trees by 12-13% due to the superior quality of the grass.

Thus, it turns out that the production and forage quality of the grasslands under the wild pears is obviously better than the one in the open field. To these is added the production of wild pears of approximately 30-50 kg / tree, which is used by cattle and other animals, whether domestic or wild [8].

Table 4. The differences between the chemical quality parameters of the grass, from open field (OF) and shaded ground (SG)

Chemical parameters for feed quality	Participation in dry matter %		Diff. + -	%
	OG	SG		
CP	17.7	22.3	+4.6	126
ASH	10.8	12.0	+1.3	112
FB	29.0	27.5	-1.5	95
ADF	33.2	32.0	-1.2	96
ADL	3.2	2.2	-1.0	69
NDF	55.8	56.0	+0.2	100
DDM	63.9	71.4	+7.6	112
DOM	60.2	68.0	+7.8	113

Conclusions

- (1) The high fodder production of about 14 t / ha of green mass, obtained in shaded land, the very good pastoral and nutritional value, are valuable data regarding the food consumed by the animals grazing in the “groves” in Jimbor locality.
- (2) The very good values of the nutrients from the soil in the shade of the wild pear trees, produce major changes in the composition of the grassland carpet, favoring, under the canopy of the trees, the development in proportion of 76.8% of the forage species.
- (3) All the aspects analyzed in this paper are the first arguments regarding the advantages of maintaining and promoting agroforestry systems with wild pears.

REFERENCES

- [1] Bueno, R., La Mantia, T. Cattle seed dispersal services and perspectives for management in a high biodiversity Mediterranean silvopastoral system; 4th World Congress on Agroforestry, p.691. Montpellier, France, (2019).
- [2] Den Herder, M., Moreno, G., Mosquera-Losada, R. M., Palma, J. H., Sidiropoulou, A., Freijanes, J. J. S., ... & Papanastasis V. P. Current extent and stratification of agroforestry in the European Union. *Agriculture, Ecosystems & Environment*, pp.241, 121-132, (2017).
- [3] Kovacs J.A. Biological, ecological and economic indicators of grasslands flora (Indicatori biologici, ecologici și economici ai florei pajiștilor). (In Romanian) ”Redacția de propagandă tehnică agricolă” Publishing House, (1979).
- [4] Marușca, T., Contributions to the evaluation of pasture productivity using the floristic releve; *Romanian Journal of Grassland and Forage Crops*, pp.19:33- 47; Cluj Napoca, România, (2019).
- [5] Marușca, T., Sustainable agro-silvo-pastoral system in the context of global climate warming (Sistemul agrosilvopastoral durabil, în contextul încălzirii globale a climei). *Revista de Silvicultură și Cinegetică XVII (30):67-76*; Editor: Society ”Progresul Silvic”, Brașov, România, (2012).
- [6] Mihăilă, E., Costăchescu, C., Dănescu, F., Popovici, L. Agroforestry systems in Romania; *Proceedings of the 4th European Agroforestry Conference – Agroforestry as Sustainable Land Use*, p.21-25; Nijmegen, The Netherlands, (2018).
- [7] Păcurar, F., Rotar, I. Methods to study and interpret the grasslands vegetation (Metode de studiu și interpretare a vegetației pajiștilor). ”Risoprint” Publishing House, Cluj – Napoca, (2014).
- [8] Șofletea, N., Curtu, L. *Dendrologie*; 2nd Ed. “Pentru viață” Publishing House, Brașov, (2008).
- [9] ***Amenajament pastoral comuna Homorod, județul Brașov, 2018.

[10] ***Software ArcGis 9.2.

[11] ***Google Earth Pro, 2019.

GRASSLANDS PRODUCTIVITY IN THE HYDROGRAPHIC BASIN OF THE ORĂȘTIE RIVER

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Abstract. *The permanent grasslands from the analysed area are located in the central part of the Orăștiei Corridor and the west of the Șureanu Mountains, from 225 -1,630 m altitude. The coverage with grassy vegetation is 91% and the average number of vascular plants on the vegetal associations is 60. The participation in the grassy carpet of fodder species reaches almost 60% and the harmful ones over 30%. The average pastoral value (PV) is 45 with differences from 60 - 80 for the most valuable associations to 5 - 7 for the degraded ones. The highest green mass production (GMP) of the grasslands was estimated at over 23 t/ha at *As. Arrhenatherum elatioris* harvested as hay and *As. Trifolium repenti - Lolietum* with 19 t/ha that has a grazing capacity of 1.6 UVM / ha in a season of 185 days. The worst results are obtained in the economically degraded associations *Viola declinatae - Nardetum*, *Junco - Molinietum*, *Botriochloetum ischaemi* and *Clinopodio - Pteridietum aquilini*, with 5 -7 PV and 0.4 - 0.8 t/ha GMP.*

Keywords: permanent grasslands, pastoral value, green mass production, grazing capacity

1. Introduction

According to studies on grassland vegetation with the establishment of phytocenoses and their classification, equally important for their management is the determination of productivity, respectively green mass production and forage quality [1].

With the elaboration of a new method for evaluating the productivity of grasslands based on floristic survey, determining the pastoral value, production and optimal grazing capacity was facilitated [6].

Knowing these economic indicators helps us to draw up on a scientific basis the projects of arrangement and subsequent management of grasslands [5, 15].

This paper is a continuation of the productivity evaluation of grasslands in our country [7, 8, 9, 10, 11, 14].

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2. Materials and Methods

The doctoral thesis “*Flora and vegetation from the Orăștie River Basin*” was analysed, belonging to biologist Ioan-Valeriu VINȚAN, guided by Prof. Paul BURESCU from the University of Oradea.

The following cenotaxonomic units were found and analysed:

- Cls. *NARDO - CALLUNETEA* Preising 1949
- Ord. *NARDETALIA* Oberd 1949
 - Al. *Potentillo - Nardion* Simon 1959
- 1. As. *Nardo - Festucetum rubrae fallax* Pușcaru et al. 1959
 - facies cu *Deschampsia flexuosa*
- 2. As. *Violo declinatae - Nardetum* Simon 1966
 - Cls. *MOLINIO - ARRENATHERETEA* Tx.1937
 - Ord. *MOLINIETALIA CAERULEAE* Koch 1926
 - Al. *Molinion caeruleae* Koch 1926
- 3. As. *Junco - Molinietum* Preising 1951
 - Al. *Agrostion stoloniferae* Soó (1933) 1971
- 4. As. *Agrostidetum stoloniferae* (Ujvárosi 1941) Burduja et al. 1956
- 5. As. *Ranunculo repenti - Alopecuretum pratensis* Ellmauer et Mucina in Mucina et al. 1993
- 6. As. *Poëtum sylvicolae* Buia et al.1959
 - Ord. *ARRHENATHERETALIA* R.Tüxen.1931
- 7. As. *Arrhenatheretum elatioris* Br-Bl. ex Scherrer 1925
 - Al. *Cynosurion* R.Tüxen.1947
- 8. As. *Festuco rubrae - Agrostietum capillaris* Horv. 1951
 - facies cu *Succisa pratensis*
- 9. As. *Trifolio repenti - Lolietum* Krippelová 1967, Resmeriță et Pop 1967
- 10. As. *Anthoxantho - Agrostietum capillaris* Sillinger 1933
 - facies cu *Euphorbia cyparissias*
 - facies cu *Dichanthium ischaemum*
 - Cls. *FESTUCO - BROMETEA* Br - Bl. et Tx. in Br-Bl 1949
 - Ord. *FESTUCETALIA VALESIACAE* Br - Bl. et Tx. in Br-Bl 1949
 - Al. *Festucion valesiaca* Klika 1931
- 11. As. *Agrostio - Festucetum valesiaca* Borislavljevič et al. 1955
 - facies cu *Thymus pulegioides*
 - facies cu *Scleranthus perennis*
- 12. As. *Festucetum rupicola* Burduja et al. 1956
 - facies cu *Teucrium chamaedrys*
- 13. As. *Botriochloetum (Andropogonetum) ischaemi* (Kristiansen 1937) Pop 1977

Cls. *TRIFOLIO - GERANIETEA SANGUINEI* Th. Müller 1961

Ord. *ORIGANETALIA VULGARIS* Th. Müller 1961

Al. *Trifolion medii* Th. Müller 1961

14. As. *Clinopodio - Pteridietum aquilini* Dihoru 1975

Different indices of forage value were used to determine the pastoral value, marked with 1 to 3 for species harmful to the grassy carpet and animal products and with 4 to 9 for species with forage value [2, 6, 12, 13].

The production evaluation was made on the basis of green mass indices from 1 to 9, to which useful phytomass coefficients were applied [4, 6].

Finally, for the grasslands used for grazing, the duration of the season and the optimal loading with animals were determined [3].

3. Results and Discussions

The 14 most important grassland associations belong to 7 phytosociological alliances (Table 1).

The grasslands are spread over an altitude interval of 1,400 m (225 - 1,630 m alt.), in all slope expositions, most sunny, on flat ground or with an inclination of up to 35 degrees.

Under these conditions, the average vegetation cover of the grasslands is 91% where there are an average of 59 species of vascular plants on a floristic survey.

The highest phytodiversity is found in As. *Festuco rubrae - Agrostetum capillaris* with 136 species and the lowest in As. *Nardo-Festucetum nigrescens* with only 33 species, due to grassland degradation.

Table 1. General data on the spread and phytodiversity of grassland associations in the Orăștie Basin

No.	Fitocenosis (association)	Alt. m	Exposition	Inclination. grade	Veg. cover. %	Species	
						No.	%
<i>Potentillo - Nardion</i>							
1	<i>Nardo-Festucetum nigrescens</i>	1,280-1,630	N,NE,SW, SE, E,	4-18	94	33	56
2	<i>Violo declinatae - Nardetum</i>	1,280-1,620	N,NE,S,SW	2-8	99	38	64
<i>Molinion coeruleae</i>							
3	<i>Junco - Molinietum</i>	310-1,200	Plane	0	87	56	95
<i>Agrostion stoloniferae</i>							
4	<i>Agrostetum stoloniferae</i>	310-320	Plane	0	89	40	68

No.	Fitocenosis (association)	Alt. m	Exposition	Inclination. grade	Veg. cover. %	Species	
						No.	%
5	<i>Ranunculo repenti - Alopecuretum pratensis</i>	225-355	Plane	0	90	47	80
6	<i>Poëtum sylvicole</i>	330	Plane	0	80	36	61
Arrhenatherion							
7	<i>Arrhenatheretum elatioris</i>	225-355	Plane	0	98	47	80
Cynosurion							
8	<i>Festuco rubrae - Agrostetum capillaris</i>	340-840	S,SE,SW, E,W,N	2-24	97	136	231
9	<i>Trifolio repenti - Lolietum</i>	290-380	Plane	0	93	58	98
10	<i>Anthoxantho - Agrostietum capillaris</i>	245-380	Plane,S,W, SE,SW	0-10	97	62	105
Festucion valesiaca							
11	<i>Agrostio - Festucetum valesiaca</i>	310-480	SW,W	14-35	91	62	105
12	<i>Festucetum rupicola</i>	235-510	SW,S,SE,W	4-28	83	72	122
13	<i>Botriochloetum ischaemi</i>	370-460	SW,W,SE	6-14	88	70	119
Trifolion medii							
14	<i>Clinopodio - Pteridietum aquilini</i>	410-980	S,W,SE,NW	6-18	92	73	124
	Average	225-1,630	Toate	0-35	91	59	100

The average participation of the forage species in the 14 grassland associations was 59% and of the harmful ones 32% (Table 2).

Obviously, the degree of participation of forage species directly influences the pastoral value and the useful production of green mass.

Table 2. Pastoral value, grass production and grazing capacity of grassland associations in the Orăștie Basin

No.	Association	Species participation		Pastoral value (ind.)	Green mass production		Grazing season (days)	Grazing capacity (LU/ha)
		Forrage	Harmful		(t/ha)	(%)		
1	<i>Nardo-Festucetum nigrescens</i>	56	38	38.6	5.39	61	105	0.79
2	<i>Violo declinatae - Nardetum</i>	7	92	4.6	0.47	5	105	0.07
3	<i>Junco - Molinietum</i>	8	79	6.0	0.38	4	155	0.04
4	<i>Agrostetum stoloniferae</i>	80	9	61.5	13.02	147	190	1.05
5	<i>Ranunculo repenti - Alopecuretum pratensis</i>	85	5	73.6	16.70	188	Hayfield	

No.	Association	Species participation		Pastoral value (ind.)	Green mass production		Grazing season (days)	Grazing capacity (LU/ha)
		Forrage	Harmful		(t/ha)	(%)		
6	<i>Poëtum sylvicole</i>	73	7	63.0	11.10	125	Hayfield	
7	<i>Arrhenatheretum elatioris</i>	95	3	82.8	23.29	262	Hayfield	
8	<i>Festuco rubrae - Agrostetum capillaris</i>	83	14	62.2	10.54	119	170	0.95
9	<i>Trifolio repenti - Lolietum</i>	88	5	82.6	19.15	216	185	1.59
10	<i>Anthoxantho - Agrostietum capillaris</i>	86	11	65.0	10.70	120	190	0.87
11	<i>Agrostio - Festucetum valesiaca</i>	69	22	38.0	4.44	50	180	0.38
12	<i>Festucetum rupicola</i>	70	13	38.8	7.75	87	185	0.64
13	<i>Botriochloetum ischaemi</i>	13	75	7.4	0.83	93	180	0.07
14	<i>Clinopodio - Pteridietum aquilini</i>	8	84	5.2	0.58	7	160	0.06
	AVERAGE	59	32	45.0	8.88	100	165	0.59

In our case, the hayfields harvested under the As. *Arrhenatherum elatioris* with 95% participation of forage species in the grass carpet, records 82.8 pastoral value (PV) and 23.29 t/ha green mass production (GMP).

For the grasslands grazed with animals belonging to As. *Trifolio repenti - Lolietum* with 88% participation of forage species, 82.6 PV and 19.15 t/ha GMP, it was estimated a load of 1.59 LU/ha in a season of 185 days.

This combination of *Lolium perenne - Trifolium repens* is common in the temporary grasslands of western Europe, with an oceanic climate [4].

The worst results were estimated in the floristically and economically degraded grassland associations, *Violo declinatae - Nardetum*, *Junco - Molinietum*, *Botriochloetum ischaemi* and *Clinopodio - Pteridietum aquilini*, with 7 - 13 participation of forage species registering between 4.6 - 7.4 PV with 0.38 - 0.83 t/ha GMP on which only 0.04 - 0.07 LU/ha can be maintained.

Through improvement and rational use, the productivity of these grasslands can be substantially increased [1, 5].

Conclusions

- (1). The permanent grasslands from the study area with an average of 60 species on a floristic survey have a fairly high phytodiversity;
- (2). The pastoral value varies from 5 - 7 for degraded grassland associations to 60 - 80 for the most valuable;

- (3). The production of green fodder varies from 0.4 - 0.8 t/ha for degraded grasslands up to 19 - 23 t/ha for the best grasslands;
- (4). The grazing capacity is very heterogeneous, starting from 0.04 LU/ha to 1.6 LU/ha, depending on the production and duration of the season;
- (5). Productivity data are important for drafting the pastoral arrangements and for proper management of these grasslands.

REFERENCES

- [1] Bărbulescu, C., Motcă, Gh. The grasslands of the high mountains (Pășunile munților înalți), (In Romanian), Ceres Publishing House, București, (1983).
- [2] Kovacs, J.A., Biological, ecological and economic indicators of the grasslands flora (Indicatori biologici, ecologici și economici ai florei pajiștilor), "Redacția de propagandă tehnică agricolă" Publishing House (1979).
- [3] Marușca T., Items of mountain gradientics and ecology (Elemente de gradientică și ecologie montană), "Transilvania" University Publishing House, Brașov, (2001).
- [4] Marușca T., Praticulture for everyone to understand (Praticultura pe înțelesul tuturor), Profesional-Agromedia SRL Publishing House, București, (2016).
- [5] Marușca, T., Mocanu, V., Haș, E. C., Tod, M., A., Andreoiu, A. C., Dragoș, M., M. M., Blaj, V. A., Ene, T., Silistru, D., Ichim, E., Zevedei, P., Constantinescu, C., Tod, S., Guide for the preparation of the pastoral arrangements (Ghid de întocmire a amenajamentelor pastorale), Capolavoro Publishing House, Brașov, 248 p. (2014).
- [6] Marușca, T., Contributions to the evaluation of pasture productivity using the floristic releve, Romanian Journal of Grassland and Forage Crops, vol. 19, pp. 33- 47 (2019).
- [7] Marușca, T., Arsene, G. G., Taulescu, E., Assessment of permanent grassland productivity in Poiana Ruscă Mountains (South-West Romanian Carpathians), Annals of the Academy of Romanian Scientists Series Agriculture, Silviculture and Veterinary Medicine Sciences BDI Online ISSN 2344 – 2085 Volume 9, Number 1/2020, pp. 62-69 (2020)
- [8] Marușca, T., Assessments on the productivity of grasslands located in the Subcarpathic area of Oltenia, according to the moisture regime expressed by vegetation, Annals of the Academy of Romanian Scientists Series on Agriculture, Silviculture and Veterinary Medicine Sciences, Volume 10, Number 1, pp. 72-78 (2021).
- [9] Marușca, T., Danciu, M., Gurean, D.M., Contributions to the evaluation of grassland from South Baraolt Mountains in terms of productivity, Annals of the Academy of Romanian Scientists Series on Agriculture, Silviculture and Veterinary Medicine Sciences, Volume 10, Number 1, pp. 79-87 (2021).
- [10] Marușca, T., Burescu, L. I.N., Evaluation of the Productivity of Permanent Grasslands from Lăzărenilor Hills, Bihor County, Romania, Annals of the Academy of Romanian Scientists Series on Agriculture, Silviculture and Veterinary Medicine Sciences, Volume 10, Number 2, pp. 13-21 (2021).
- [11] Marușca, T., Roman, A., Taulescu, E., Ursu T.M., Popa R. D., Detecting trends in the quality and productivity of grasslands by analyzing the historical vegetation relevés: A case study from

- Southeastern Carpathians, Vlădeasa Mountains (Romania), *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, Volume 49, Issue 3, Article number 12378, (2021).
- [12] Păcurar, F., Rotar, I., *Methods to study and interpret grasslands vegetation (Metode de studiu și interpretare a vegetației pajiștilor)*. Risoprint Publishing House, Cluj – Napoca (2014).
- [13] Păcurar, F. *Indicative species for the evaluation and management of high value grasslands systems (Specii indicatoare pentru evaluarea și elaborarea managementului sistemelor de pajiști cu înaltă valoare - HNV)*. Casa Cărții de Știință Publishing House, Cluj - Napoca. (2020).
- [14] Pășcuț, C. Gh., Marușca, T., *Studies regarding the evolution of grassland productivity from Codru Moma Mountains (Western Carpathians)*, *Annals of the Academy of Romanian Scientists Series on Agriculture, Silviculture and Veterinary Medicine Sciences*, Volume 9, Number 2/2020 (2020).
- [15] Samfira, I., (coord.), *Guide applied for the elaboration of the pastoral arrangement. Case studies. Methodology and legislation (Îndrumar aplicat pentru elaborarea amenajamentului pastoral, Studii de caz, Metodologie și Legislație)*, Mirton Publishing House, Timișoara, (2021).

PRODUCTIVITY EVALUATION OF THE MAIN GRASSLAND HABITATS, NATURA 2000, FROM THE RARĂU MASSIVE (EASTERN CARPATHIANS)

TEODOR MARUȘCA¹

Abstract. *Grassland types of Rarău Massif with soils formed on a calcareous geological substrate (dolomite) have a very high phytodiversity, on average 91 species of plants on a floristic survey. The overall vegetation cover was almost 90% of which over 60% forage species and almost 30% harmful species. Of the 12 main grassland types, 3 are xerophilous, 2 mesoxerophilous and 7 mesophilous. The most species-rich mesophilous grasslands are *Festuca rubra* and *Festuca nigrescens* with 135-154 taxones per survey. The highest pastoral value (PV) was assessed at Habitat 6510 of almost 68 PV where the highest production of 13.6 t/ha of green mass production (GMP) was estimated when using the grassland as hayfield. At Habitat 6520, where the grassland was grazed with animals, it was estimated 51.5 PV, over 7 t/ha GMP that supports 0.84 LU/ha in 130 days grazing season. In the same Habitat 6520 there are grasslands with grassy carpet degraded by *Nardus stricta* and *Deschampsia caespitosa*, where we have 20 PV and 2 t/ha GMP with 0.30 LU/ha. The rest of the habitats have a lower productivity, respectively habitat 6170, due to the altitude and a colder climate and habitat 6210 with a drier climate. On average, the productivity of the habitats is quite good with 42 PV, 6.4 t/ha GMP and 0.6 LU/ha in 120 days of grazing.*

Keywords: mountain grasslands, types and habitats, pastoral value, green mass production, grazing capacity

1. Introduction

Knowledge of the productivity of permanent grasslands at the level of grassland habitats registered in Natura 2000 is an urgent need if we are to be able to compare and develop joint projects in this field with other countries in the European Union [2, 6].

For this purpose, a method has been developed to evaluate the productivity of grasslands based on a floristic survey [4, 5, 7].

All productivity assessments so far have been carried out according to surveys drafted using the phytosociological method Braun - Blanquet, with the main purpose of classifying vegetation into associations, alliances, orders and classes [1].

This is the first work in which surveys have been made to determine the types of grasslands based on dominant species in the grassy carpet.

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Regardless of the method in which the floristic observations were made, a well-drafted survey with the notation of the abundance - dominance of the species or the direct appreciation in percentages of their participation in the grass carpet, are sufficient for the further assessment of grassland productivity.

2. Materials and Methods

For reference, the work “Vegetation of the grasslands from the Rarău Massif” was studied, belonging to P. Raclaru, where the classification of the grassland associations took into account the typological principle of species dominance in the grassy carpet [8].

At the higher level, the grasslands were classified according to the humidity factor, being noted 3 types of xerophilous grasslands, 2 types of mesoxerophilous grasslands and 9 types of mesophilous grasslands (Table 1).

Table 3. General data on the vegetation and phytodiversity of the grasslands from Rarău Massif

Type (association)	Altitude (m)	Veg. cover (%)	Species (no.)	Species participation (%)	
				Forage	Harmful
Xerophilous grasslands					
<i>Festuca saxatilis</i>	1,400-1,600	82	111	55	27
<i>Festuca amethystina</i>	1,400-1,600	82	73	59	23
<i>Carex sempervirens</i>	1,400-1,600	78	37	75	3
Mesoxerophilous grasslands					
<i>Festuca ovina</i>	600-1,200	88	130	62	26
<i>Festuca rupicola</i>	600-1,000	82	61	65	17
Mesophilous grasslands					
<i>Festuca nigrescens</i>	1,300-1,600	90	135	59	31
<i>Nardus stricta</i>	1,300-1,600	92	80	20	72
<i>Deschampsia caespitosa</i>	1,300-1,600	88	52	37	54
<i>Festuca rubra</i>	600-1,200	95	154	65	30
<i>Agrostis capillaris</i>	600-1,200	92	87	72	20
<i>Trisetum flavescens</i>	600-1,000	100	96	86	14
<i>Arrhenatherum elatius</i>	600-800	100	78	85	15
AVERAGE	600-1,600	89	91	62	27

The average phytodiversity of these mountain grasslands is very high, having a number of 91 plant species. By number of species, the richest types were *Festuca*

rubra with 154 taxons and *F. nigrescens* with 135 taxons. The lowest phytodiversity was on types *Carex sempervirens* and *Nardus stricta* with 37-52 taxons.

The vegetation cover is 88%, of which 62 with forage species and 27 species harmful to grassy carpet or animal products.

Recorded data on the types of grassland with vegetation cover, phytodiversity, species participation in floristic surveys continued to be used to calculate pastoral value, green mass production and grazing capacity according to the new method widely described in our annals [5] and other specialized publications [4, 7], so I will not describe it again.

3. Results and Discussions

Calculations on grassland productivity as types determined by dominant species have been introduced in Grassland Habitats Natura 2000, according to our latest classification [3].

The actual results of pastoral value (PV) and green mass production (GMP), components of a grassland's productivity were summarized at Natura 2000 habitat level (Table 2).

Table 4. Productivity of the main grassland habitats in the Rarău Massif

Association Habitat *)	Pastoral value		Green mass production		Grazing season duration	Animal loading LU/ha
	ind.	%	t/ha	%		
1. 6170 Alpine and subalpine calcareous grasslands						
<i>Carex sempervirens</i>	34.9		3.44		100	0.53
<i>Festuca amethystina</i>	31.7		5.04		100	0.78
<i>Festuca saxatilis</i>	30.6		5.32		100	0.82
AVERAGE	32.4	77	4.60	72	100	0.71
2. 6210 Semi-natural dry grasslands and scrubland facies on calcareous substratea (<i>Festuco-Brometea</i>) (*important orchid sites) (Al. <i>Festucion valesiaca</i>)						
<i>Festuca ovina</i>	37.0		5.13		145	0.54
<i>Festuca rupicola</i>	38.4		3.91		150	0.40
AVERAGE	37.7	90	4.52	71	150	0.47
3. 6510 Lowland hay meadows (<i>Alopecurus pratensis</i> , <i>Sanguisorba officinalis</i>)						
<i>Arrhenatherum elatius</i>	67.0		14.42		x	x
<i>Trisetum flavescens</i>	68.3		12.74		x	x

Association Habitat *)	Pastoral value		Green mass production		Grazing season duration	Animal loading LU/ha
	ind.	%	t/ha	%		
AVERAGE	67.7	162	13.58	214	Fâneată	
4. 6520 Mountain grasslands (Syn. Mountain hay meadows) (Al. <i>Cynosurion cristati</i>)						
<i>Festuca nigrescens</i>	42.9		6.14		105	0.90
<i>Festuca rubra</i>	45.9		6.35		145	0.67
<i>Agrostis capillaris</i>	65.8		8.78		145	0.93
AVERAGE	51.5	123	7.09	111	130	0.84
5. 6520 Mountain degraded grasslands						
<i>Nardus stricta</i>	13.1		1.35		105	0.20
<i>Deschampsia caespitosa</i>	27.1		2.68		105	0.39
AVERAGE	20.1	48	2.02	32	105	0.30
Habitat Rarău AVERAGE	41.9	100	6.36	100	120	0.58

*) Habitats according to EU, Natura 2000

The average pastoral value of these mountain grasslands was evaluated at 41.9 PV with a production of 6.36 t/ha GMP and an optimal capacity of 0.58 LU/ha in 120 days grazing season.

The highest productivity is in the *Arrhenatherum elatius* and *Trisetum flavescens* grasslands type belonging to Habitat 6510, where 67.7 PV and 13.58 t/ha GMP were evaluated.

The lowest productivity was assessed in the grassland types invaded by the harmful species *Nardus stricta* and *Deschampsia caespitosa*, which were included in the degraded Habitat 6520, where 20.1 PV and 2.02 t/ha GMP were assessed, which can only sustain 0.30 LU/ha in 105 days, grazing period.

Closer to the average were Habitat 6170 at high altitude, with colder climate, and Habitat 6210 at lower altitude, with drier climate.

Conclusions

- (1) When evaluating productivity, floristic surveys can be used to determine the types of grasslands, provided they are well drafted;
- (2) The phytodiversity is very high, being on average 91 species on a floristic survey, the vegetation cover was 90% of which over 60% forage species and 30% harmful species;

(3) The highest productivity was evaluated in Habitat 6510 with 68 pastoral value (PV) and 13.6 t/ha green mass production (GMP), harvested as hay for the grassland types *Arrhenatherum elatius* and *Trisetum flavescens*;

(4) Habitat 6520 has the lowest productivity, being degraded by the invasion of *Nardus stricta* and *Deschampsia caespitosa* species where 20 PV and 2 t/ha GMP were evaluated, with 0.30 LU/ha animal loading, 2.5 times less than the normal variant of Habitat 6520 where 51.5 PV, over 7 t/ha GMP was registered, with a capacity of 0.84 LU/ha in 130 days grazing season;

(5) The average productivity of these mountain grasslands, located between 600 - 1600 m altitude, with 42 PV, 6.4 t/ha GMP and 0.6 LU/ha in 120 days of grazing, is considered to be quite good.

REFERENCES

- [1] Cristea, V., Gafta, D., Pedrotti, F., Fitosociologie (Phytosociology), Presa Universitară Clujeană Publishing House (2004).
- [2] Doniță, N., Popescu, A., Paucă-Comănescu, M., Mihăilescu, S., Biriș I.A., Habitats of Romania (Habitatele din România), Tehnică și silvică Publishing House, București (2005).
- [3] Gafta, D., Mountford, O. (coord.), Textbook for interpreting the Natura 200 habitats of Romania (Manual de interpretare a habitatelor Natura 2000 din România), Risoprint Publishing House, Cluj-Napoca (2008).
- [4] Marușca, T., Contributions to the evaluation of pasture productivity using the floristic releve, Romanian Journal of Grassland and Forage Crops, vol. 19, pp. 33- 47 (2019).
- [5] Marușca, T., Arsene, G. G., Taulescu, E., Assessment of permanent grassland productivity in Poiana Ruscă Mountains (South-West Romanian Carpathians), Annals of the Academy of Romanian Scientists Series Agriculture, Silviculture and Veterinary Medicine Sciences Volume 9, Number 1/2020, pp. 62-69 (2020).
- [6] Marușca, T., Contributions to the assessment of Natura 2000 Habitat productivity of mountain pastures in Padurea Craiului (Southern-Eastern Carpathians), Romanian Journal of Grassland and Forage Crops, Cluj Napoca, nr.23 pp. 99-104, (2021).
- [7] Marușca, T., Roman, A., Taulescu, E., Ursu, T.M., Popa, R. D., Detecting trends in the quality and productivity of grasslands by analyzing the historical vegetation relevés: A case study from Southeastern Carpathians, Vlădeasa Mountains (Romania), Notulae Botanicae Horti Agrobotanici Cluj-Napoca, Volume 49, Issue 3, Article number 12378, (2021).
- [8] Raclaru, P., Grasslands vegetation in the Rarau Massive (Vegetația pajistilor din Masivul Rarău), Comunicări de Botanică, A- V-a Consfătuire de Geobotanică, București, pp.143-177, (1967).

CONTRIBUTION TO THE ASSESSMENT OF MOUNTAIN GRASSLANDS PRODUCTIVITY FROM RÂMNICU SĂRAT RIVER BASIN

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Abstract. *The aim of this study is to assess the grasslands of the Râmnicu Sărat river basin, lying in Buzău and Vrancea counties, to the Curvature Carpathians, in terms of forage species, as well as to determine their productivity, pastoral value (PV), green fodder mass (GM) production and the optimal load of herbivores per hectare (Large Cattle Units). The permanent grasslands of Râmnicu Sărat river basin are spread up to 1340 m altitude above sea level, on flat lands and aspects, up to 30 degrees slopes, where, on average 85 species of plant species are found within a single plant community. The vegetation coverage is in average of 94%, of which 66% participation with fodder species and 28% with harmful species to grass carpet and animal production. The best pastoral value (PV) of 74.8 and a production of 16.62 t/ha of green fodder mass (GM) was evaluated within the ass. *Cirsio cani-Festucetum pratensis* and the lowest of 5.6 PV, with 0.56 t/ha GM within ass. *Festuco capillatae-Nardetum*. The average production of the assessed grasslands was of 7.22 t/ha GM, which allows a load of 0.73 LCU/ha, for an average period of 165 days of grazing, the lowest number being of 125 days in the mountain area and 195 days in the hilly area, for transhumant domestic animals.*

Keywords: grasslands, phytodiversity, green mass production, pastoral value, grazing capacity

1. Introduction

Determining the meadows productivity (in terms of green mass production and forage quality) is one of the main economic indicators on the basis of which decisions are taken regarding those measures in order to improve the vegetational cover, the farmers being able this way to establish the optimal grazing capacity with domestic animals [17].

Researches on the evaluation of grassland productivity based on floristic survey are incipient in Romania, still being easier to apply with quite good results.

In practice, it is quite difficult to determine the grasslands productivity, the classical methodology requiring fenced areas of various grassland types in more difficult to access areas, such are the mountain grasslands.

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For these reasons, a new methodology to assess the productivity of grasslands based on floristic survey was developed [2, 3, 15, 16).

To date, several assessments have been made on the productivity of grasslands in different mountain areas in Romania [4-14].

This paper continues the evaluation the productivity of mountain grasslands, in this case the Basin of Râmnicu Sărat river, Vrancea Mountains, that continue to serve to a better management of meadows, with appropriate improvement measures and suitable grazing capacity, projected in pastoral arrangements.

2. Materials and Methods

The studied area belongs to the Vrancea Mountains, namely the upper and middle basin of the Râmnicu Sărat river. Vrancea Mountains are a subunit of the Curvature Carpathians, on a North-South direction with a length of 79 Km, and on a West-East direction on a length of 20-35 Km. Vrancea Mountains are of middle heights (the highest peaks are Goru, of 1,785 m a.s.l. (above sea level) and Lăcăuți, of 1,777 m a.s.l.), made on the deposits of the external flysch (as they are conglomerates, marls, sandstones, clays, etc.), of Cretaceous and Palogenic ages [21, 23].

In the upper belt of vegetation of Vrancea Mountains (over 1,600 m alt. a.s.l.) the meadows belong to vegetation class *Juncetea trifidi* Hadač in Klika et Hadač 1944 (on very small patches, not mapped and unevaluated within this paper), and to vegetation class *Calluno-Ulicetea* Br.-Bl. et R. Tx. ex Klika et Hadač 1944. The climate is cold, the average yearly of temperatures being of ± 2 °C, and the average yearly of precipitation of $> 1,000$ mm.

In the middle belt of vegetation (1,200-1,600 m alt. a.s.l.) the meadows belong to vegetation class *Molinio-Arrenatheretea* Tx. 1937. The average yearly of temperatures is 2 – 4 °C, and the the average yearly of precipitation of 800 - 1,000 mm. The soils are mostly brown acids.

In the lower belt of vegetation (under 1,200 m alt. a.s.l.) the vast majority of meadows belong to vegetation class *Molinio-Arrenatheretea* R. Tx. 1937; only, on sunny and exposed slopes the meadows belong to vegetation class *Festuco-Brometea* Br.-Bl. et Tx. 1943 ex Klika et Hadač 1944. The average yearly of temperatures is 4 – 6 °C, and the the average yearly of precipitation of 700 - 900 mm. The soils are mostly brown acids and brown humics.

Along paths, roadsides, potholes and so on, the meadows belong to vegetation class *Polygono arenastri-Poetea annuae* Rivas-Martinez 1975 corr. Rivas-Martinez et al. 1991 [22].

The studied area includes large surfaces of meadows/grasslands (used both as hayfields or pastures), very valuable in terms of fodder. They form a large feeding base for grazing animals (sheep, goats, cows, horses), as well as for wild herbivores in the area. The meadows are distributed from the lower part to the top of the mountains. It was found that the upper limit of the tree line was artificially lowered by a height of 300-400 m altitude, as a result of its massive deforestation in order to expand the secondary hayfields and pastures [22].

The area of Râmnicu Sărat river basin was chosen by the authors considering that the Romanian legislation in the field obliges the administrative-territorial units from the whole country to evaluate their potential grasslands to support an optimal number of animals that graze, avoiding thus to destroy them.

The Romanian legislation obliges the administrative-territorial units from the whole country to evaluate their potential grasslands in order to support an optimal number of domestic animals that graze on them.

The actual working methodology was presented in detail in the pages of this scientific journal, for the evaluation of the productivity of the meadows in the Perșani Mountains, the reason why we do not return to it [3].

The plant nomenclature was adopted in conformity with the on-line european flora (continuously updated) (<https://www.emplantbase.org/home.html>) and the most recent identification field book for vascular plants in Romania [20].

The coenotaxonomic system used in this paper is according to the most accepted operas that deal the subject of Romanian vegetation cover [1, 18, 19].

3. Results and Discussions

In order to evaluate the productivity of the grasslands, the floristic surveys from the report no. 2 of doctoral thesis entitled “Researching the flora and vegetation in the upper and middle basin of the Râmnicu Sărat river” were used, drafted in 1980 by biologist Nicolae Ștefan under the guidance of Professor dr. Constantin Burduja, from the University “Alexandru Ioan Cuza” of Iași, Faculty of Biology-Geography.

As a general note, the permanent meadows belong to the upper basin of Râmnicu Sărat river, in the Vrancea Mountains, while the middle basin of the same river is situated in the hilly area of Buzău county.

The grassland of the studied area were framed according to some of the coenotaxonomic classifications in use for the Romanian vegetation [1, 18, 19].

The coenotaxonomic classification is as the next:

Cl. **CALLUNO-ULICETEA** Br.-Bl. et R. Tx. ex Klika et Hadač 1944 (Syntax. syn.: Cl. **NARDO-CALLUNETEA** Preising 1949)

Ord. **NARDETALIA** Oberd. 1949

Al. **Potentillo-Nardion** Simon 1958

1. Ass. *Violo declinatae-Nardetum* Simon 1966 (Syntax. syn.: Ass. *Nardetum strictae montanum* Resm. et Csűrös 1963)
2. Ass. *Scorzonero roseae-Festucetum nigrescentis* (Pușcaru et al. 1956) Coldea 1987 (Syntax. syn.: 4. Ass. *Festucetum rubrae montanum* Csűrös et Resm. 1960)

Al. **Violion caninae** Schwickerath 1944

3. Ass. *Festuco capillatae-Nardetum* Klika et Šmarda 1944 (Syntax. syn.: Ass. *Nardus stricta* + *Bruckenthalia spiculifolia* I. Șerbănescu 1961)

Cl. **MOLINIO-ARRENATHERETEA** R. Tx. 1937

Ord. **ARRHENATHERETALIA** R. Tx. 1931

Al. **Cynosurion** R. Tx. 1947

4. Ass. *Festuco rubrae-Agrostetum capillaris* Horv. 1951 (Syntax. syn.: 6. Ass. *Agrostetum tenuis* auct. roman.; Ass. *Agrostetum tenuis montanum* Szafer, Pawł. et Kulkz. 1923)
 - 4a. subass. *typicum* (5. Syntax. syn.: Ass. *Festuceto-Agrostetum tenuis montanum* Csűrös et Resmeriță 1960)
 - 4b. subass. *nardetosum strictae* Oroian 1998 (3. Syntax. syn.: Ass. *Festuceto-Nardetum strictae montanum* Csűrös et Resmeriță 1960)
5. Ass. *Trifolio repentis-Lolietum perennis* Krippelova 1967 (Syntax. syn.: 10. Ass. *Lolieto-Trifolietum repentis* Resm. et al. 1967)
6. Ass. *Agrosteto-Festucetum sulcatae* Csűrös et Kaptalan 1964

Ord. **MOLINIETALIA** W. Koch 1926

Al. **Deschampsion caespitosae** Horvatić 1930

7. Ass. *Cirsio cani-Festucetum pratensis* Májovský et Ružičová 1975 (Syntax. syn.: Ass. *Festucetum pratensis* Soó 1938)
8. Ass. *Poëtum pratensis* Răvăruț, Căzăceanu et Turenschi 1956

Ord. POTENTILLO-POLYGONETALIA R. Tx. 1947

Al. Potentillion anserinae R. Tx. 1947

9. Ass. *Rumici crispi-Agrostetum stoloniferae* Moor 1958 (Syntax. syn.: Ass. *Agrostetum stoloniferae* Soó 1957)

Cl. FESTUCO-BROMETEA Br.-Bl. et Tx. 1943 ex Klika et Hadač 1944

Ord. *FESTUCETALIA VALESIACAE* Br.-Bl. et R. Tx. ex Br.-Bl. 1949

Al. Festucion valesiaca Klika 1931

10. Ass. *Medicagini-Festucetum valesiaca* Wagner 1941 (Syntax. syn.: 12. Ass. *Festucetum valesiaca* Burduja et al. 1956)
11. Ass. *Taraxaco serotini-Botriochloëtum ischaemi* (Burduja et al. 1956) Sârbu, Coldea et Chifu 1999 (Syntax. syn.: 13. Ass. *Botriochloa ischaemum* Burduja et al. 1956, non Ass. *Botriochloëtum ischaemi* (Krist 1937) I. Pop 1977)
12. Ass. *Agropyretum pectiniforme* Prodan 1939 em. Dihoru 1970

Cl. POLYGONO ARENASTRI-POETEA ANNUAE Rivas-Martinez 1975 corr. Rivas-Martinez et al. 1991

Ord. *POLYGONO ARENASTRI-POETALIA ANNUAE* R. Tx. in Géhu et al. 1972 corr. Rivas-Martinez et al. 1991

- Al. Matricario matricarioidis-Polygonion arenastri** Rivas-Martinez 1975 corr. Rivas-Martinez et al. 1991 (Syntax. syn.: Al. *Polygonion avicularis* Br.-Bl. 31 em Tx. 1950)
13. Ass. *Sclerochloo durae-Polygonetum avicularis* Soó ex Kornek 1999 corr. Mucina 1993 (Syntax. syn.: 15. Ass. *Polygonetum avicularis* Gams 1927)
14. Ass. *Poëtum annuae* Felföldy 1942 (Syntax. syn.: 16. Ass. *Poëtum annuae* Gams 1927)

The praticole plant communities (i. e. plant associations, associations for short) in the upper and middle basin of the Râmnicu Sărat river from upstream to downstream are found from 1,340 m altitude a.s.l. in the mountainous area, down to 110 m altitude a.s.l. in the area of low hills towards the plain, on flat lands or various slopes, between 5 and 30 degrees, on all aspects (Table 1).

Table 1. General data on site conditions and plant communities of grasslands in the upper and middle basin of the Râmnicu Sărat river

Nr. crt.	Plant community	Altitude (average/extremes) (m a.s.l.)	Aspect	Slope (degrees)	Vegetation coverage (%)	Plant species	
						no	%

Nr. crt.	Plant community	Altitude (average/extremes) (m a.s.l.)	Aspect	Slope (degrees)	Vegetation coverage (%)	Plant species	
						no	%
1	<i>Festuco capillatae-Nardetum</i>	1,165 (1,020-1,315)	flat ground, E, W, S-E, N-E, N-W	0-5	100	40	47
2	<i>Violo declinatae-Nardetum</i>	1,045 (1,030-1,060)	flat ground, E, W, S-W	0-5	98	38	45
3	<i>Festuco rubrae-Agrostetum capillaris nardetosum strictae</i>	1,160 (1,100-1,270)	E, S-E, S-W, N-E	5-20	98	67	79
4	<i>Scorzonero roseae-Festucetum nigrescentis</i>	1,170 (890-1,340)	E, S-E, S-W, W	15-30	100	87	102
5	<i>Festuco rubrae-Agrostetum capillaris typicum</i>	835 (745-900)	N-E, S-E, E, S-W, W, S, N	5-35	95	124	146
6	<i>Festuco rubrae-Agrostetum capillaris</i>	840 (750-920)	S-E, N-E, W, N-E, N-W	5-25	97	124	146
7	<i>Cirsio cani-Festucetum pratensis</i>	500 (375-620)	S-W, N-W, S, E, N	5-20	97	123	145
8	<i>Poëtum pratensis</i>	470 (195-760)	S-E, N-E, N- W, W, E	5-20	98	104	122
9	<i>Rumici crispi-Agrostetum stoloniferae</i>	385 (220-520)	flat ground, E, N-E, N-W, S-W, S	0-15	94	115	135
10	<i>Trifolio repentis-Lolietum perennis</i>	300 (210-380)	flat ground, N-E, E, W	0-5	95	78	92
11	<i>Agrosteto-Festucetum sulcatae</i>	545 (430-635)	E, S-W, N-E, S	5-25	94	80	94
12	<i>Medicagini-Festucetum valesiaca</i>	280 (110-390)	flat ground, S-E, S-W, S, N-W	0-30	91	122	144
13	<i>Taraxaco serotini-Botriochloëtum ischaemi</i>	185 (120-240)	flat ground, N-E, E, W, N	0-25	89	95	111
14	<i>Agropyretum pectiniforme</i>	175 (110-270)	flat ground, S, E, S-E	0-25	91	67	79
15	<i>Sclerochloo durae-Polygonetum avicularis</i>	235 (125-430)	flat ground, S-E, E, W	0-3	81	52	61
16	<i>Poëtum annuae</i>	480 (360-500)	flat ground, S-E, N-E, E, S-W	0-5	83	44	52

Nr. crt.	Plant community	Altitude (average/extremes) (m a.s.l.)	Aspect	Slope (degrees)	Vegetation coverage (%)	Plant species	
						no	%
	TOTAL AVERAGE	600 (110-1,340)	All	0-30	94	85	100

Data source: all the data processed in table no. 1 were taken over, with the consent of the author, from the report no. 2 of the doctoral thesis of Professor Nicolae Ștefan (Ștefan 1980).

The average vegetation cover was 94%, with limits between 81-83% for the plant associations *Sclerochloo durae-Polygonetum avicularis* and *Poëtum annuae* up to 100% in *Festuco capillatae-Nardetum* and *Scorzonero roseae-Festucetum nigrescentis*.

In terms of the number of vascular plant species (=Cormophytes), the grasslands from the study area are particularly rich, with an average of 85 species. The highest plant diversity, with over 120 species, was registered within the plant associations *Festuco rubrae-Agrostetum capillaris typicum*, *Cirsio cani-Festucetum pratensis*, and *Medicagini-Festucetum valesiacae*.

In contrast to the above situation, the lowest plant diversity, with about 40 species, was found to be inside the plant associations *Violo declinatae-Nardetum*, *Festuco capillatae-Nardetum*, and *Poëtum annuae*.

The mountain grasslands having a small number of plant species indicate an advanced stage of degradation due to their invasion by matgrass (*Nardus stricta*), as well as by other non-valuable plant species from fodder point of view.

As a matter of fact, the grasslands productivity is proportionally influenced by the participation in the grassy cover of the plant species with fodder values that reaches in on average 66%, and of the harmful ones of 28% (Table 2).

Table 2. Feeding value and green mass production of praticalous plant communities in Râmnicu Sărat basin river

No. crt.	Plant communities	Species participation		Pastoral value		Green mass production	
		Fodder plants	Harmful plants	(ind.)	%	t/ha	%
1	<i>Festuco capillatae-Nardetum</i>	9	91	5.6	12	0.56	7
2	<i>Violo declinatae-Nardetum</i>	10	88	6.3	13	0.65	8
3	<i>Festuco rubrae-Agrostetum capillaris nardetosum strictae</i>	48	50	35.4	75	5.30	67
4	<i>Scorzonero roseae-Festucetum nigrescentis</i>	88	12	66.6	140	13.20	166
5	<i>Festuco rubrae-Agrostetum capillaris</i>	80	15	59.8	126	10.56	133

No. crt.	Plant communities	Species participation		Pastoral value		Green mass production	
		Fodder plants	Harmful plants	(ind.)	%	t/ha	%
	<i>typicum</i>						
6	<i>Festuco rubrae-Agrostetum capillaris</i>	80	17	60.8	128	10.43	132
7	<i>Cirsio cani-Festucetum pratensis</i>	81	16	74.8	158	16.62	210
8	<i>Poëtum pratensis</i>	89	9	69.3	146	12.39	156
9	<i>Rumici crispi-Agrostetum stoloniferae</i>	83	11	58.4	123	11.39	144
10	<i>Trifolio repentis-Lolietum perennis</i>	80	15	69.0	146	12.85	162
11	<i>Agrosteto-Festucetum sulcatae</i>	82	12	51.9	109	10.53	133
12	<i>Medicagini-Festucetum valesiaca</i>	72	19	42.1	89	5.04	64
13	<i>Taraxaco serotini-Botriochloëtum ischaemi</i>	17	72	10.4	22	1.39	18
14	<i>Agropyretum pectiniforme</i>	77	14	43.3	91	5.08	64
15	<i>Sclerochloo durae-Polygonetum avicularis</i>	74	7	43.9	93	5.90	74
16	<i>Poëtum annuae</i>	78	5	60.5	128	4.93	62
	AVERAGE	66	28	47.4	100	7.93	100

Data source: all the data processed in table no. 2 were taken over, with the consent of the author, from the report no. 2 of the doctoral thesis of Professor Nicolae Ștefan (Ștefan 1980).

The highest proportion in the grassy carpet of 88-89% of fodder plant species is found in the plant associations *Festuco rubrae-Agrostetum capillaris* and *Poëtum pratensis*, and the lowest, of 9-10%, within those plant communities dominated by the matgrass (*Nardus stricta*) and 17% fodder plant species at *Taraxaco serotini-Botriochloëtum ischaemi* in the hilly area.

The pastoral value, directly influenced by the participation and quality of the fodder plant species is 47.4 (moderate) for the study area.

The highest pastoral value, of 74.8, was evaluated for the plant community *Cirsio cani-Festucetum pratensis*, which is used for hay production, and the lowest one, of 13, for the plant *Violo declinatae-Nardetum*, still being used irrationally for grazing.

The average production of green fodder is of 7.93 t/ha, with the best production of 16.62 t/ha (210% compared to the averages) for the plant community *Cirsio cani-Festucetum pratensis*, and the weakest production of green fodder, of 0.56- 0.65 t/ha to those dominated by the matgrass (*Nardus stricta*).

Between these two extreme figures, the difference in fodder green mass production is more than 27 times larger than that of this economic factor on which domestic animal production depends.

Finally, based on the production data, the optimal grazing capacity was established, at the level of phytocoenological alliances assimilated in general with the new habitats, which is 0.73 Large Cattle Units (LCU)/ha, for a season of 165 days of grazing, corresponding to an altitude of 600 m a.s.l. (Table 3).

Table 3. Optimal length of the grazing season, average green mass production and loading with domestic animals at the level of phytocoenological alliances (habitats)

Plant alliances	Average altitude (m a.s.l.)	Grazing season length (in days)	Green mass production (t/ha)	Animal loading (LCU/ha)	Productivity assessment
<i>Potentillo-Nardion</i>	1,110	125	0.61	0.08	degraded
<i>Violion caninae</i>	1,000	135	9.87	1.12	medium
<i>Deschampsion cespitosae</i> *	430	180	11.89	1.02	medium
<i>Cynosurion cristati</i>	420	180	11.69	1.00	medium
<i>Festucion valesiaca</i>	210	195	3.84	0.30	very low
<i>Matricario matricarioidis-Polygonion arenastris</i>	360	185	5.42	0.45	low
AVERAGE	600	165	7.22	0.73	moderate

* without ass. *Cirsio cani-Festucetum pratensis*, harvested as hay

Data source: all the data processed in table no. 3 were taken, with the consent of the author, from the report no. 2 of the doctoral thesis of Professor Nicolae Ștefan (Ștefan 1980).

The highest grazing capacity, of 1.0-1.12 LCU/ha, is achieved, in order, on the grasslands within the next plant alliances: Al. *Cynosurion/Deschampsion cespitosae* for 180 days of grazing, and Al. *Cynosurion* for 135 days of grazing.

It must be said that the meadows included within the plant association *Cirsio cani-Festucetum pratensis* (Al. *Deschampsion caespitosae*), harvested for hay, were not included on these calculations.

Obviously, the lowest load of only 0.08 LCU/ha was evaluated, as expected, for Al. *Potentillo-Nardion*, which is 14 times lower than the neighboring meadows within the Al. *Cynosurion*.

Due to the very large difference in grazing capacity, between the better managed mountain grasslands of Al. *Cynosurion*, and the poorest productive ones of Al. *Potentillo-Nardion* existing in close pedoclimatic conditions, the existing potential of currently degraded grasslands is noticeable.

Conclusions

- (1) The Romanian legislation obliges the administrative-territorial units from the whole country to evaluate their potential grasslands in order to support an optimal number of domestic animals that graze on them.
- (2) The grassland of the upper basin of Râmnicu Sărat river are in the Vrancea Mountains, while the middle basin of the same river is situated in the hilly area of Buzău county.
- (3) The coenotaxonomic system adopted in this paper includes 14 plant associations, and 2 subassociations, from 7 alliances of vegetation, 6 order of vegetation, and 4 classes of vegetation.
- (4) The fodder plant communities in the upper and middle basin of the Râmnicu Sărat river are found from 1,340 m altitude a.s.l. in the mountainous area, down to 110 m altitude a.s.l. in the area of low hills towards the plain, on flat lands or various slopes, on all aspects (East, West, North, and South).
- (5) The average vegetation coverage is of 94%, varying between 81-83% for some of the plant associations (*Sclerochloa durae-Polygonetum avicularis*, *Poëtum annuae*) and 100% for other plant associations (*Festuco capillatae-Nardetum*, *Scorzonero roseae-Festucetum nigrescentis*).
- (6) The grasslands in the upper and middle basin of the Râmnicu Sărat river are particularly rich in vascular plant species, with an average of 85 per each plant community; the highest number, of over 120 plant species, was registered within some of the plant associations (*Festuco rubrae-Agrostetum capillaris typicum*, *Cirsio cani-Festucetum pratensis*, and *Medicagini-Festucetum valesiaca*); the lowest number of plant species, of about 40 species, was registered for some of the plant associations (*Violo declinatae-Nardetum*, *Festuco capillatae-Nardetum*, *Poëtum annuae*).
- (7) The mountain grasslands with a small number of plant species indicate usually advanced stages of degradation due to invasion by *Nardus stricta*, as well as by other non-valuable plant species from fodder point of view.
- (8) The average production of green fodder was 7.93 t/ha, with an index of 47.4 pastoral value, with large differences between various plant associations and phytocoenological alliances.

(9) The average grazing capacity in 165 days of the season was assessed at 0.73 LCU/ha, respectively from over 1 LCU/ha within the plant alliances *Cynosurion cristati* and *Deschampsion caespitosae*, to 0.08 LCU/ha on degraded grasslands of the Al. *Potentillo-Nardion*.

REFERENCES

- [1] Coldea, Gh. (ed.), Oprea, A., Sârbu, I., Sîrbu, C., Ştefan, N., Les associations végétales de Roumanie. Tome 2. Les associations anthropogènes. Cluj-Napoca: Presa Universitară Clujeană Publishing House, 482 pp (2012).
- [2] Kovacs, A. J., Biological, ecological and economic indicators of the grasslands flora (Indicatorii biologici, ecologici și economici ai florei pajiștilor), Redacția de propagandă tehnică agricolă Publishing House, București, 50 pp (1979).
- [3] Marușca, T., Contributions to the evaluation of pasture productivity using the floristic releve, Romanian Journal of Grassland and Forage crops, 19: 33-47 (2019).
- [4] Marușca, T., Taulescu, E., Roșca, V., Bajenaru, B., Memedemin, D., Contributions to the evaluation of grassland productivity on the Macinului Mountains National Park, Romanian Journal of Grassland and Forage Crops, 20: 17- 26. (2019).
- [5] Marușca, T., Nicolin, A. L., Contributions to the study of the impact of grassland phyto-coenoses in the upper and middle Timiș river basin on forage and livestock production (Banat, Romania). USAMVB "Regele Mihai I- al României", Research Journal of Agricultural Science, Timișoara, 52(1): 159-166 (2020).
- [6] Marușca, T., Ionescu, I., Taulescu, E., Simion, I., Malinas, A., Contributions to the evaluation of the productivity of permanent grassland from North Oltenia, Romanian Journal of Grassland and Forage Crops, 21: 49-59 (2020a).
- [7] Marușca, T., Arsene, G. G., Taulescu, E., Assessment of permanent grassland productivity in Poiana Ruscă Mountains (South-West Romanian Carpathians), Annals of the Academy of Romanian Scientists Series Agriculture, Silviculture and Veterinary Medicine Sciences, 9(1): 62-69 (2020b).
- [8] Marușca, T., Ularu, P., Gurean, D. M., Dragoș, M. M. M., Taulescu, E., Contributions to the grassland productivity evaluation in the Perșani Mountains, Jurnalul de Montanologie, 13: 23-32 (2020c).
- [9] Marușca, T., Contribuții la evaluarea productivității ecologice a pajiștilor din Masivul Vlădeasa (Munții Apuseni), Academia de Științe Agricole și Silvicultură "Gheorghe Ionescu Șișești", Acta Agricola Romanica, Seria Cultura plantelor de câmp, 3(3): 38-44 (2021a).
- [10] Marușca, T., Contributions to the assessment of Natura 2000 Habitat productivity of mountain pastures in Padurea Craiului (Southern-Eastern Carpathians), Romanian Journal of Grassland and Forage Crops, Cluj Napoca, 23: 99-104 (2021b).
- [11] Marușca, T., Taulescu, E., The Need for Grassland Productivity Assessment for the Economical Development of Mountain Area (Case Study, Ciucaș Mountains), Journal of Mountain Agriculture on the Balkans, Research Institute of Mountain Stockbreeding and Agriculture, Troyan, 24(6): 313-329 (2021).

- [12] Marușca, T., Danciu, M., Gurean, D. M., Contributions to the evaluation of grassland from South Baraolt Mountains in terms of productivity, *Annals of the Academy of Romanian Scientists, Ser. Agriculture, Silviculture and Veterinary Medicine Sciences*, 10(1): 79-87 (2021a).
- [13] Marușca, T., Roman, A., Taulescu, E., Ursu T.M., Popa, R. D., Detecting trends in the quality and productivity of grasslands by analyzing the historical vegetation relevés: A case study from Southeastern Carpathians, Vlădeasa Mountains (Romania), *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 49(3) (2021b).
- [14] Marușca, T., Oprea, A., Sîrbu, C., Samuil, C., Evaluation of the productivity of grass phytocoenoses of the Stănișoarei Mountains (Eastern Carpathians), *Romanian Journal of Grassland and Forage Crops*, Cluj Napoca, 24: 15-22 (2021c).
- [15] Păcurar, F., Rotar, I., *Methods to study and interpret the vegetation of the grasslands (Metode de studiu și interpretare a vegetației pajiștilor)*, Risoprint Publishing House, Cluj-Napoca (2014).
- [16] Păcurar, F., *Indicative species for the evaluation and management of high value grasslands systems (Specii indicator pentru evaluarea și elaborarea managementului sistemelor de pajiști cu înaltă valoare naturală - HNV)*, Casa Cărții de Știință Publishing House, Cluj-Napoca (2020).
- [17] Samfira, I. (coord.), *Guide applied for setting up the pastoral arrangement. Case studies. Methodology and legislation (Îndrumar aplicat pentru elaborarea amenajamentului pastoral. Studii de caz, Metodologie și Legislație)*. Mirton Publishing House, Timișoara (2021).
- [18] Sanda, V., Popescu, A., Doltu, M. I., *Cenotaxonomia și corologia grupărilor vegetale din România. Stud. Comunic., Muz. Brukenthal, Sibiu*, 24(supl.): 6-172 (1980).
- [19] Sanda, V., Popescu, A., Barabaș, N., *Cenotaxonomia și caracterizarea grupărilor vegetale din România. Compl. Muz. Ști. Nat. Bacău*, Edit. "I. Borcea", 366 pp (1998).
- [20] Sârbu, I., Ștefan, N., Oprea, Ad., *Romania's vascular plants. Illustrated determinant for the field (Plante vasculare din România. Determinator ilustrat de teren)*. București, Victor B Victor Publishing House, (2013).
- [21] Ștefan, N., *Cercetarea florei și vegetației din bazinul superior și mijlociu al râului Râmnicu Sărat*, Referat doctorat no. 2. Universitatea "Alexandru Ioan Cuza", Iași (1980).
- [22] Ștefan, N., Ștefan, P., Davidescu, G., *Evoluția vegetației în Munții Vrancei din cuaternar. Bul. Grăd. Bot. Iași*, 5: 159-164 (1995).
- [23] ****Geografia României*, 3. Acad. Româna Publishing House, București (1987).

THE DYNAMIC OF COMMERCE AND LOGISTIC ECONOMIC SECTORS IN THE CONTEXT OF INDUSTRY 4.0. EVIDENCES FROM THE EUROPEAN AND ROMANIAN MOUNTAIN ENTREPRENEURSHIP

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Abstract. *The paper presents the conceptual and statistical dynamic of the Wholesale and Retail Commerce, Repair of Motor Vehicles and Motorcycles and Transport and Storage economic sectors in the European mountain area. European mountain entrepreneurship and commerce develops considerably in the 20th century, especially in the context of the industrial revolutions. The article analyzes the evolution of the commerce and logistic sectors between 2008-2018 and highlights the importance of the classic commerce in the contexts of e-commerce and pandemic approach. The results show that both analyzed sectors present an activity intensification during 2008-2018 period, but especially in the pandemic context.*

Keywords: commerce, industry 4.0., logistic, mountain entrepreneurship

1. Introduction

From the first industrial revolution (year 1760, the period of industrial development associated with steam engines) to Industry 4.0 (the interaction of objects with people), the evolution of commerce and its associated logistic experienced a development that dismantled and rearranged world socioeconomic patterns. The defining factors were both Industry 2.0 (electrification and mass production) and Industry 3.0 (development of electronics, telecommunications and computers, as well as online commerce - especially against the background of globalization) [3].

Although online commerce (more immaterial) has irreversibly marked the state of world commerce, classical (material) commerce continues to be the structural basis of commerce. The classic commerce - material - will always be up to date, and the physical logistic related to transport and storage will be a problem that will require a continuous solution. This is because the immaterial in economics can only be supported by material. In this context, commerce and logistic are

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important dominants of European as well as Romanian development. Both Europe as a whole and Romania as a separate case must be focused on the development of material and immaterial commerce. The poles of commercial power have gradually shifted from the old continent to continents / regional groups - from the penultimate (19th century) and ultimate (20th) emerging wave, such as North America, Asia, BRICS, and so on [2].

Structurally, three phenomena have left their mark on the development of world commerce, specifically urbanization, aging population and digitalization [7].

2. Materials and methods

First of all, the paper is based on a large literature on the topic which creates the scientific updated framework.

Even the technology forces the e-commerce development, consumer behavior is oriented to material retail more than immaterial retail; this is the reason why retailers “adopt new, attractive and exciting technologies to catch consumers and improve the retail management strategies” [6].

At the entrepreneurial level, e-commerce must be sustained by classic commerce. European entrepreneurship follows the rules of horizontal economic growth, known as organic growth [5]. Otherwise, companies will have an untenable growth. The best example of this principle is the conjuncture given by the new pandemic context. Under the current pandemic, the offline retail industry is stagnant, and at the same time the rest of the world economy. The pandemic has caused huge losses for the retail industry and has also developed opportunities with difficult-to-quantify results for e-commerce [8].

In recent decades, European realities have shown that the structure of the retail sector has undergone considerable changes throughout the Community. In the second half of the twentieth century, consumption patterns in developed market economies stabilized, while countries in transition developed only after the 1990s. presented an unusual dynamic after the 1990s. The rapid adaptation of Western European markets to Western norms was supported by the insertion and domination of Western capital. The potential of eastern markets, which are under-exploited domestically, as well as permissive legislation, and the consumer-oriented behavior of Western products have attracted Western retailers. The boom in the opening of Eastern markets to Western entrepreneurs has been decisive for the economic growth of the Western business sector, which is facing considerable stagnation in the 1990s. In the second half of the twentieth century, consumption patterns in developed market economies stabilized the economies of Western European countries, while countries in transition experienced this development much later, mainly at the time of EU accession. Today, the differences, changes

and trends of Western Europe are widely accepted and applied in the post-socialist countries of Europe. Eastern countries have become pillars of emerging development in the European Union, and then true partners for becoming a community. European commerce, as well as the Romanian one, has metamorphosed considerably from the 1990s to the present. As a result, there have been changes in purchasing habits, consumer behavior and preferences, with the commerce union occurring faster than in other dimensions of the *acquis communautaire*. At the level of commerce practiced by large retailers, consumer behaviors, both Western and Eastern, have become uniform intragenerationally as well as transgenerationally. However, at the level of local commerce, consumer preferences have diversified considerably, with local and regional markets receiving specific support from corporate and public governance in Europe [4].

In the paper, the authors present the results of the statistical simulation for the European and Romanian commerce and logistic the mountain entrepreneurship (population of active enterprises from the mountain area). Data has been taken from Eurostat and simulated in Excel and SPSS [1].

According to Eurostat, the specific categories of commerce and logistic classes, for 2008-2018 period, are Wholesale and Retail Commerce, Repair of Motor Vehicles and Motorcycles and Transport and Storage.

3. Results and Discussions

3.1. Wholesale and Retail Commerce, Repair of Motor Vehicles and Motorcycles

At the European level, statistics on the evolution of the economic sector Wholesale and retail commerce, repair of motor vehicles and motorcycles (Figure 1, panels a - f) shows, mainly average values of 82,827.64 (Bulgaria), 561,775.18 (Italy), 51,836.73 (Austria), 60,643 (Portugal), 77,409 (Romania), 66,766 (Slovakia), with standard deviations of 4,747.31 (Bulgaria), 24,040,658 (Italy), 1,098,528 (Austria), 3,920,721 (Portugal), 12,693,011 (Romania), 3,422,343 (Slovakia).

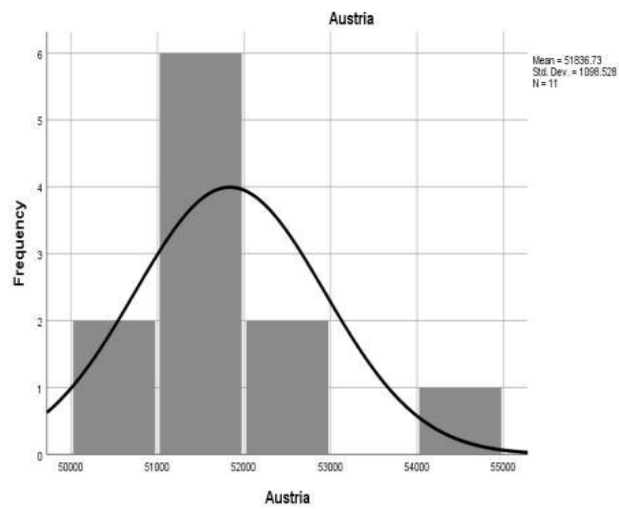


Fig. 1. a. Histogram for wholesale and retail commerce; repair of motor vehicles and motorcycles - Austria

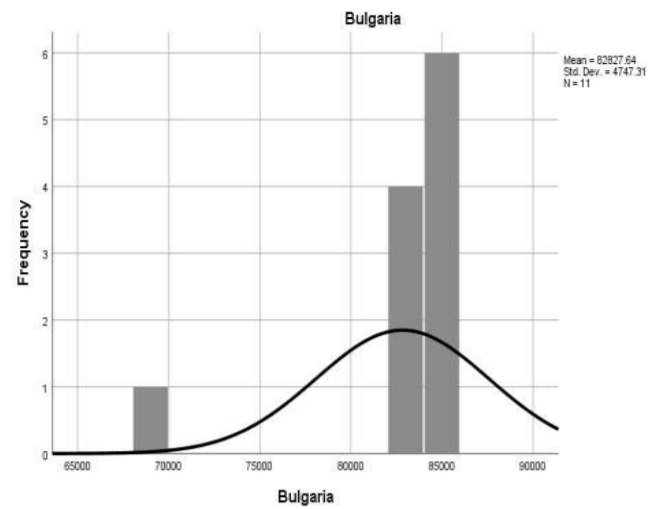


Fig. 1. b. Histogram for wholesale and retail commerce; repair of motor vehicles and motorcycles - Bulgaria

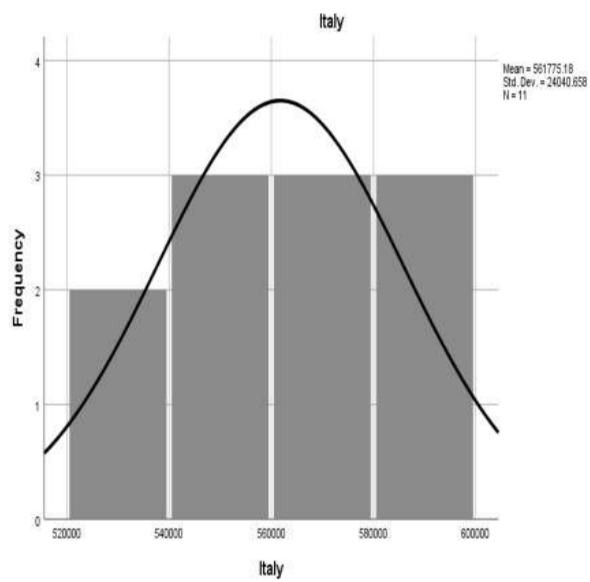


Fig. 1. c. Histogram for wholesale and retail commerce; repair of motor vehicles and motorcycles - Italy

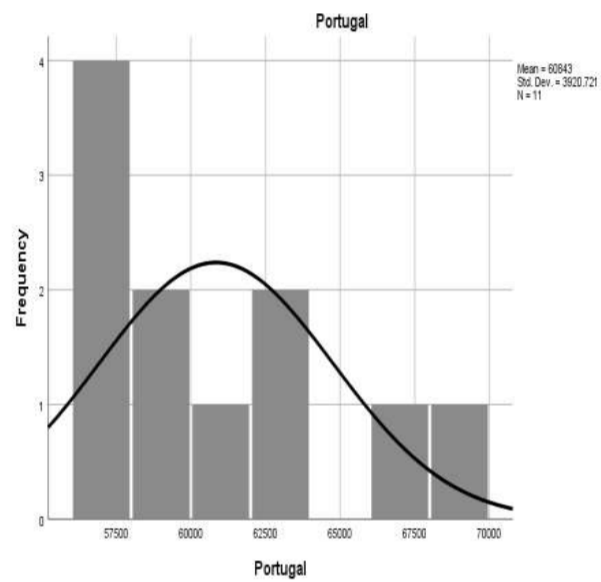


Fig. 1. d. Histogram for wholesale and retail commerce; repair of motor vehicles and motorcycles - Portugal

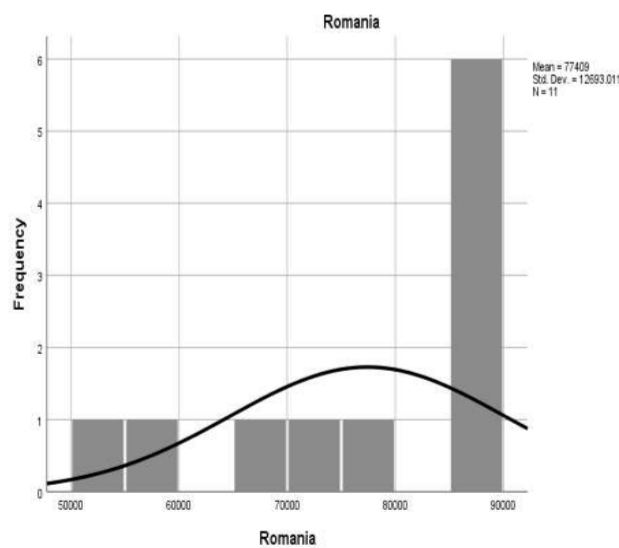


Fig. 1. e. Histogram for wholesale and retail commerce; repair of motor vehicles and motorcycles - Romania

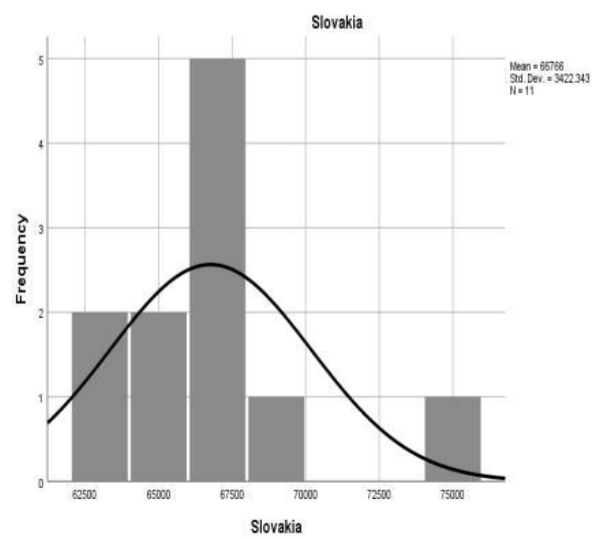


Fig. 1. f. Histogram for wholesale and retail commerce; repair of motor vehicles and motorcycles - Slovakia

Source: Author processing according to Eurostat data - Business Demography Statistics.

Regarding the Romanian realities, the statistics related to the evolution of the field of activity Wholesale and retail commerce; the repair of motor vehicles and motorcycles (Figure 2, panels a-b) shows mainly an average value of 77,409 with a standard error of 12,693.011.

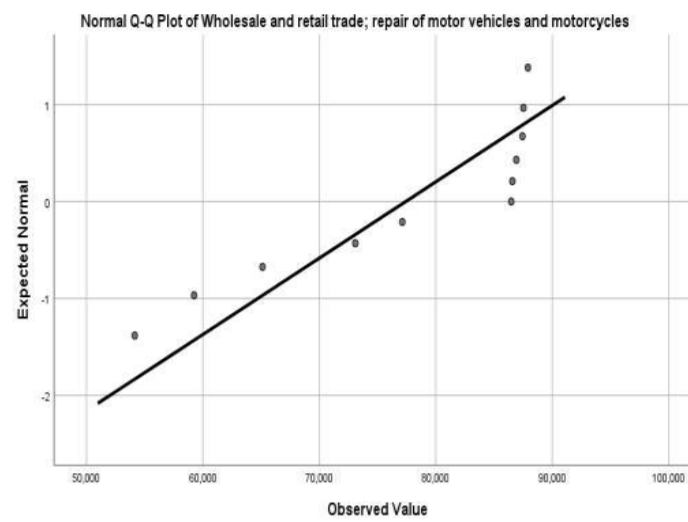
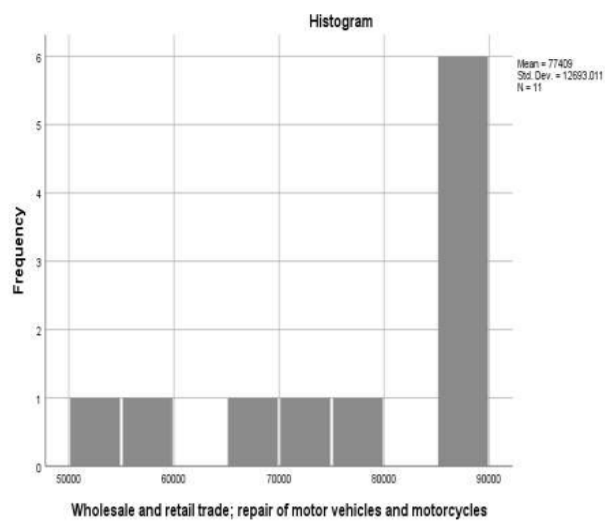


Fig. 2. a. Histogram for wholesale and retail commerce, repair of motor vehicles and motorcycles

Fig. 2. b. Distribution chart Q-Q normal plot for Wholesale and Retail; repair of motor vehicles and motorcycles by logarithm

Source: Author processing according to Eurostat data - Business Demography Statistics.

3.2. Transport and storage

Statistics for the economic sector Transport and storage (Figure 3, panels a-f) show averages of 12,462.91 (Bulgaria), 58,331.27 (Italy), 8,762.45 (Austria), 5,976.45 (Portugal), 18,845.27 (Romania), 8,660.73 (Slovakia), with standard deviations of 1,543,081 (Bulgaria), 3,774,077 (Italy), 359.93 (Austria), 398.84 (Portugal), 5,262,442 (Romania), 1,120, 484 (Slovakia).

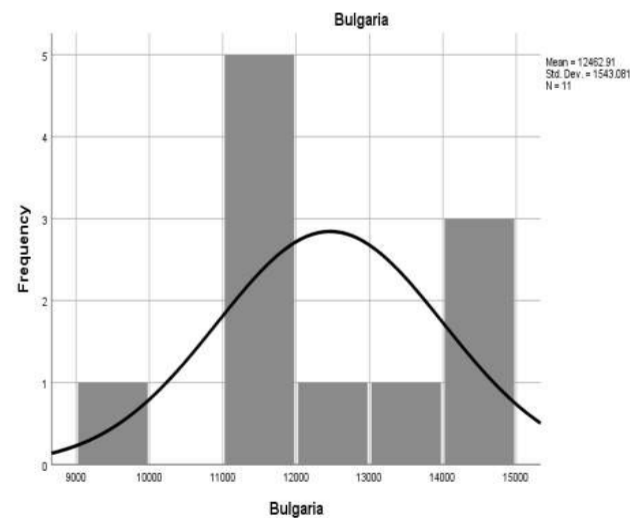
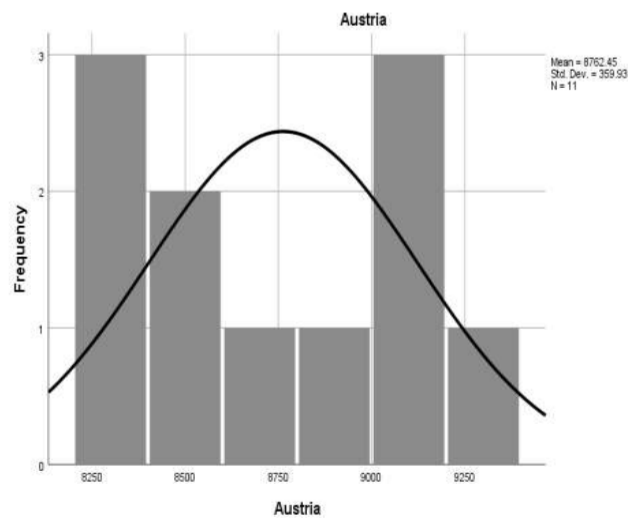


Fig. 3. a. Histogram for the Transport and Storage Sectors - Austria

Fig. 3. b. Histogram for the Transport and Storage Sectors – Bulgaria

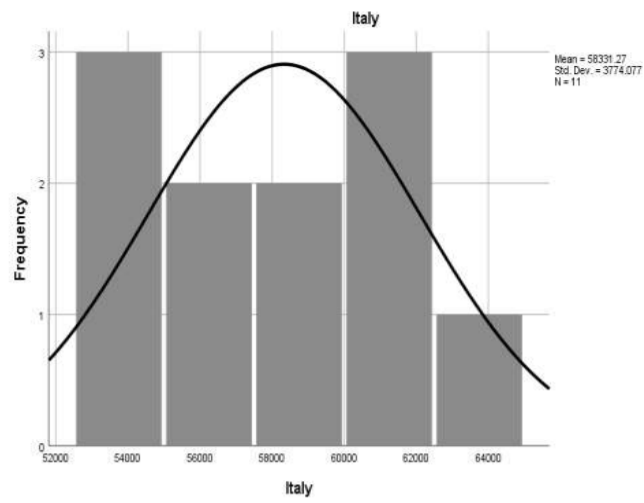


Fig. 3. c. Histogram for the Transport and Storage Sectors - Italy

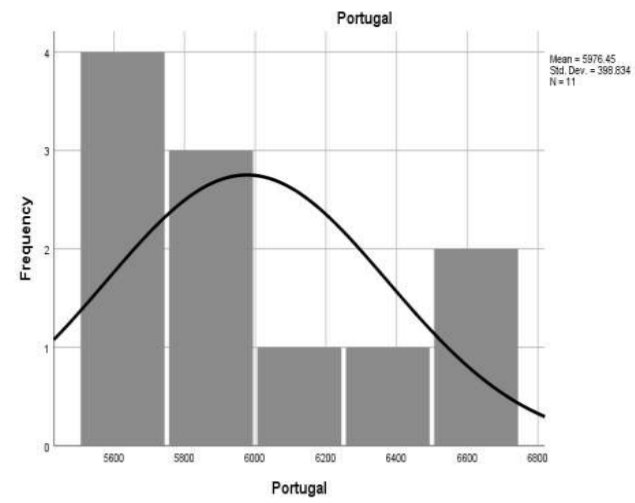


Fig. 3. d. Histogram for the Transport and Storage Sectors - Portugal

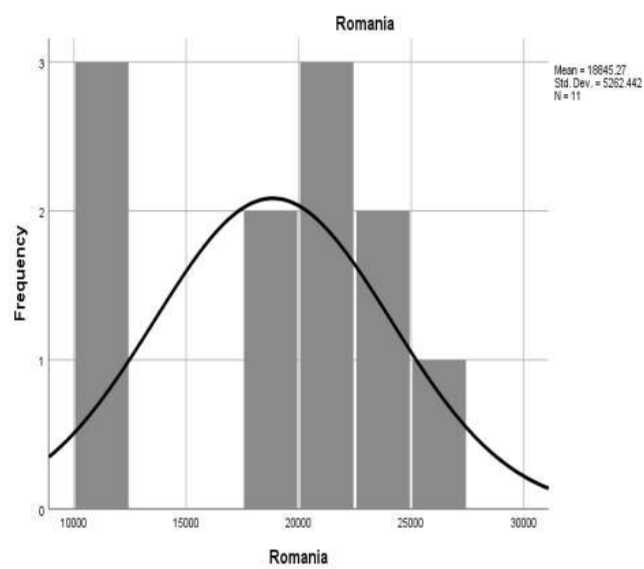


Fig. 3. e. Histogram for the Transport and Storage Sectors - Romania

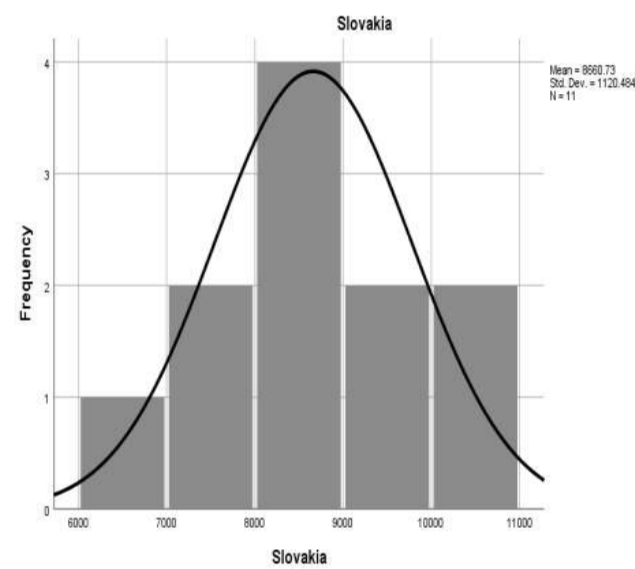


Fig. 3. f. Histogram for the Transport and Storage Sectors - Slovakia

Source: Author processing according to Eurostat data - Business Demography Statistics

The statistics for the Romanian economic sector Transport and storage (Figure 4, panels a-b) show an average of 18,845.27 with a standard error of 5,262.442.

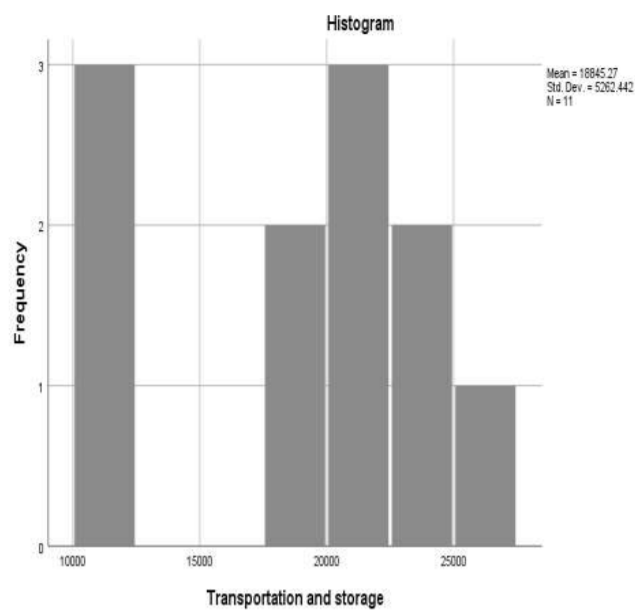


Fig. 4. a. Histogram for the economic sector Transport and storage

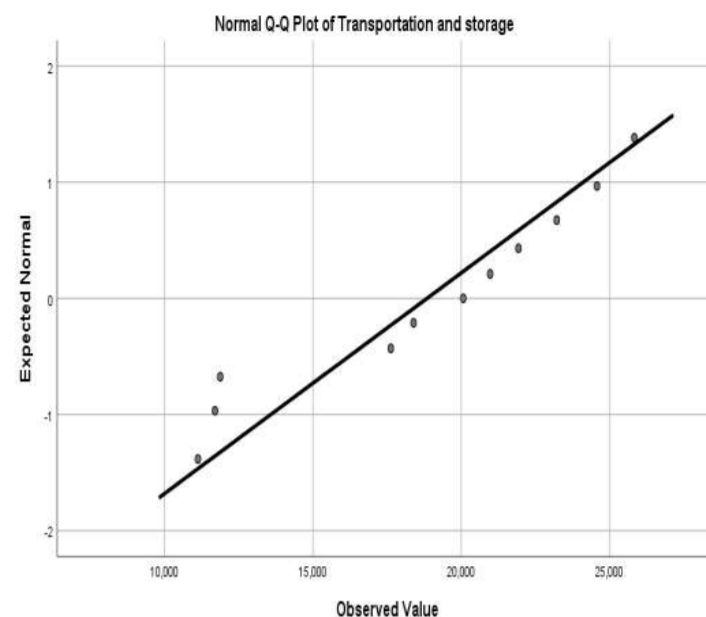


Fig. 4. b. Graph of the Q-Q normal plot distribution for the Transport and storage economic sector, by logarithm

Source: Author processing according to Eurostat data - Business Demography Statistics

At the European level, both for the Wholesale and retail commerce, repair of motor vehicles and motorcycles and Transport and storage sectors, the distribution curves of the presented countries are relatively symmetrically central, and the scores around the mean are very concentrated, with the appearance of leptocurtosis, although the distribution is unimodal. Working hypothesis: the distribution of scores is considered normal and therefore parametric tests will be applied.

The extreme values of the distribution, although in very small numbers, change the appearance of the histogram, by inducing a positive asymmetry, being still statistically important. The concentration of a large number of scores around the averages produces a certain leptocurtosis of the distribution, due to the related phenomena in the European mountain economy.

The logarithm of the values obtained, according to the universally accepted statistical rules, allowed to balance the distribution according to the normal Gauss-Laplace curve.

The importance of these tests is given by the need to carefully observe the influences of certain factors in the evolution of wholesale and retail commerce; repair of motor vehicles and motorcycles. Following the application of normality tests, after logarithmization, the null hypothesis must be rejected and the working hypothesis can be analyzed.

The descriptive and inferential analysis was done considering the distribution of scores within normal limits, according to the working hypothesis, for which the parametric tests are applied.

The central trend for this sector in the analyzed period shows that the European mountain population of the active enterprises in the studied sector increased from 2008 to 2018. In the analyzed period, the hypothesis of activity intensification was verified. The statistics, presented above, and the histogram confirm the intense agglomeration and development trend of this sector in mountain Europe. At the same time, the statistics confirm the intensification of the growth of this sector.

At the Romanian level, at first glance, the distribution curves are relatively symmetrically central, and the scores around the mean are very concentrated, with the appearance of leptocurtosis, although the distribution is unimodal.

Working hypothesis: the distribution of scores is considered normal and therefore parametric tests will be applied. The extreme values of the distribution, although in very small numbers, change the appearance of the histogram, by inducing a positive asymmetry, being still statistically important. The concentration of a large number of scores around the average produces a certain leptocurtosis of the distribution, due to the related phenomena in the Romanian economy. The logarithm of the values obtained, according to the universally accepted statistical rules, allowed to balance the distribution according to the normal Gauss-Laplace curve.

The Q-Q normal plot test, after logarithm, shows a distribution of real scores around normal values, represented by the oblique line on the graph, which corresponds to a normal distribution.

The Q-Q detrended plot test, on the dispersion of empirical scores to normal, represented by the right with the score $z = 0$ for average and standard deviation 1, after logarithm, shows that they fall within a standard deviation, corresponding to a normal distribution.

By logarithm, the scores obtained were subjected to a statistical processing, after which all the factors involved in the study were taken into account, in order to obtain data as close as possible to the reality recorded in Romania, even if the measures taken in the economy unbalanced the distribution of scores. short period of time.

The importance of these tests is given by the need to carefully observe the influences of certain factors in the evolution of the economic sector “Wholesale and retail commerce; repair of motor vehicles and motorcycles”. Following the application of normality tests, after logarithmization, the null hypothesis must be rejected and the working hypothesis can be analyzed. The descriptive and inferential analysis was done considering the distribution of scores within normal limits, according to the working hypothesis, for which the parametric tests are applied.

The central trend for this economic sector in the analyzed period shows that the population of mountainous Romania of active enterprises in the studied sector increased from 2008 to 2018. In the analyzed period, the intensification of activity hypothesis was verified.

The statistics, presented above, and the histogram confirm the intense agglomeration and the development trend of this sector in Romania. At the same time, the statistics confirm the intensification of the growth of this economic sector.

Conclusions

- (1) The paper analyzed statistical dynamic of the Wholesale and Retail Commerce, Repair of Motor Vehicles and Motorcycles and Transport and Storage economic sectors in the European mountain area.
- (2) The results pointed out that the European mountain entrepreneurship and commerce developed considerably in the 20th century, especially in the context of the industrial revolutions.
- (3) The analysis of the evolution of the commerce and logistic sectors between 2008-2018 highlighted the importance of the classic commerce in the contexts of e-commerce and pandemic approach.
- (4) The results showed that the both analyzed sectors present an activity intensification during 2008-2018 period, but especially in the pandemic context.
- (5) In Romania, it was also noticed that the population of mountainous Romania of active enterprises in the studied sector increased from 2008 to 2018.
- (6) Also, in the analyzed period, the empirical results emphasized an intensification of the activity in the both studied sectors.

R E F E R E N C E S

- [1] Eurostat, Wholesale and Retail Commerce, Repair of Motor Vehicles and Motorcycles and Transport and Storage, <https://inspire.ec.europa.eu/codelist/EconomicActivityNACEValue/G>, (2022).
- [2] Fernie, J. Retail logistics. In Handbook of Logistics and Supply-chain Management. Emerald Group Publishing Limited. (2017).
- [3] Har, L. L., Rashid, U. K., Te Chuan, L., Sen, S. C., Xia, L. Y. Revolution of Retail Industry: From Perspective of Retail 1.0 to 4.0. *Procedia Computer Science*, 200, 1615-1625 (2022).
- [4] Kunc, J., Križan, F. Changing European retail landscapes: New trends and challenges. *Moravian Geographical Reports*, 26, 3, 150-159 (2018).

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- [5] Moatti, V., Ren, C. R., Anand, J., Dussauge, P. Disentangling the performance effects of efficiency and bargaining power in horizontal growth strategies: An empirical investigation in the global retail industry. *Strategic Management Journal*, 36, 5, 745-757 (2015).
- [6] Pantano, E., & Vannucci, V. Who is innovating? An exploratory research of digital technologies diffusion in retail industry. *Journal of Retailing and Consumer Services*, 49, 297-304 (2019).
- [7] Plazibat, I., Dadić, M. Contemporary issues in the retail industry. *The Journal of Corporate Governance, Insurance, and Risk Management (JCGIRM)*, 2, 44-53 (2017).
- [8] Yang, Y. The impact of the epidemic on the retail industry. 2020 2nd International Conference on Economic Development and Management Science (EDMS 2020).

FROM EMPIRISM TO ERGONOMICS

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Abstract. *Empiricism means to rely only on experience, without theoretical content. in Romania the premises are marked by numerous researches, such as: Occupational medicine, Philosophy, Psychology, etc., that have led to practical applications. It is known the initiative of the ECOFOREST Association of Neamț County, Romania which has regulated the profession of Ergonomist that is already implemented by 28 graduates in Romania. The topic of the work is the regulation of the „Ergonomics Technician” profession for high-school graduates. The paper includes: Justifying memorandum, Appendix to the justifying memorandum covering the studies and analyses on the labour market carried out by The Ecoforest Association of Neamt. Description of Occupation.*

Keywords: initiative, profession, occupation, C.O.R. (Classification of occupations in Romania), memorandum, Ergonomics Technician

1. Introduction

In literature, there are presented several variants of empiricism, from which we have learned that the empiric focuses only on experience that denies the objective existence of the material world and considers the sensory experience as the first source of knowledge. Nevertheless, there were times when the organization could be traditionally performed, with a minimum of information on previous progress, common sense, talent, creative spirit and a lot more work.

Nowadays, however, neither the common sense nor the talent can solve the problems of progress. Computers, genetic engineering, in high tech devices in general are the result of a long-term training, the same is the organization and scientific leadership and the development of ergonomics. Common sense and talent are of great value, especially when doubled by a high level training otherwise they remain sources of stagnation or even regression.

So, in today's world, the post-industrial era or the STR (the scientific and technical revolution) there are ongoing changes in the way we understand the basis of progress in the most various areas from which we need to start, from what is already known, from the latest-reached level of development.

A brilliant mind can make progress that institutions in the most civilized countries cannot sometimes achieve.

We need technical competence, technology and "top" organization and ergonomics must be based on high scientific, technical and professional competence to cope with the speed of progress. Today, we are asked a judgement facing the new realities, in terms of our future.

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The literature of ergonomics, economy, management, human resources, interior design, psychology, occupational health, sociology, environmental protection, legislation (Ordinance 129 of 2000 on adult training) [9], etc. created the background/basis for the documentation on the legislation of the occupation of **Ergonomics Technician**.

2. Materials and methods

The aim of this work/study is to present the historical stages from empiric to specific, namely “Legislating on the profession of **Ergonomics Technician**”, with the introduction in the Classification of Romania Occupations (C.O.R.) of the profession of **Ergonomics Technician** with six characters 325729, which opens the doors to vocational training for graduates with med-level education over sustainable periods.

Informative materials used to draft this work:

Professional or trade literature: books of ergonomics, management, human resources, sociology, professional training, occupational safety and health;

Up-to-date books elaborated by the authors: Susana Geangălău - coordinator and her colaborators “**Ergonomie aplicativă în sistemul OM – COMPUTER – MEDIU**” – 2012, Aurel Manolescu - coordinator and his colaborators – “**Ergonomie organizațională**” – 2015, Valentin Nedeff and colaborators – “**Ergonomie**” – 2021

Mass media articles: (The magazine ECONOMISTUL, February, the 21st, 2005, Interview with Univ. Prof. Petre Burloiu, Adjunct Professor with the Academy of Economics of Bucharest

Methods:

Specific methods: study of working methods, interrogative method, methods of measuring

the working time, method of organizing the workplace, the ergonomic Check-list, RNUR method, LEST method, SAVIEM method, ERGOS method, IEMRCM method, etc.

Non-specific methods (borrowed from other sciences): anthropometric methods, statistic-

economic methods, heuristic methods, brainstorming, ELECTRE, Philips, Delphi, the interview method and target groups, etc.

The structure of the work:

a) Justifying memorandum

b) Appendix to the justifying memorandum

c) Description of occupation.

a) Justifying memorandum - for revising the C.O.R. list with the occupation of “Ergonomics Technician”, in accordance with **Order no. 270/273 of the 12th of June 2002** issued by the **Ministry of Labor and Social Solidarity and the National Institute of Statistics** [4], regarding the approval of the procedure for updating the normative act of the Romanian occupations, Art. 8.

➤ **DESCRIPTION OF OCCUPATION**, in Romanian, for which it is applied for into COR: - **Ergonomics Technician**

➤ **THE C.O.R. CODE FOR THE MAJOR GROUP**, as well as the C.O.R. code for occupation to be entered in the **NATIONAL CLASSIFICATION OF OCCUPATIONS OF ROMANIA**:

The major group

3 – Technicians and associate professionals

32 – Health associate professionals

325 – Other health associate professionals

The National COR code for the major group:

3257 – Environmental and Occupational Health inspectors and Associates

This major group refers to the environmental and occupational health inspectors and associates who investigate the implementation of the rules and regulations relating to environment factors likely to affect human health and safety in the workplace, as well as safety of the processes for the production of goods and services. They may implement and evaluate programs to restore or improve safety and sanitary conditions under the supervision of a health professional.

The National COR code for the proposed occupation to be introduced into C.O.R.:

325729 –Ergonomics Technician

➤ **THE ECONOMIC ACTIVITY CODE of the Classification of Economic Activities in European Community (CAEN), which involves the introduction of the proposed occupation, in order to achieve the consistency between the activity and the occupation;**

Ergonomics Technician

Classification list CAEN REV.2

SECTION M – Professional, scientific and technical activities

DIVISION 74 – Other professional, scientific and technical activities

GROUP 749 – Other professional, scientific and technical activities n.e.c.

CLASA 7490 - Other professional, scientific and technical activities n.e.c.

3. Results and discussions

The studies and analyses carried out by the “ECOFORREST” Association of Neamț on the labour market, showing the need and opportunity to revise the classification of Romanian occupations (COR) for the occupation of “Ergonomics Technician”.

b) Appendix to the justifying memorandum –

Changes in the structure of the national economy (Article 5(a) ORDER No. 270/273 of June, 12th, 2002 concerning the approval of the procedure for updating the **Classification of occupations of Romania**)

➤ **The adaptation of Ergonomics to changes** in the structure of the national economy over the last 30 years is completely differentiated by the division of active enterprises, by activities of the national economy and by size classes between 0-9 employees, 10-49 employees, 50-249 employees and over 250 employees (NACE Rev. 2) [2]. This division has also led to changes in the organizational structure of small-sized, medium-sized and large-sized companies, with an impact on employees' duties and responsibilities, based on the need to assimilate new professional knowledge, skills, professional competences and particularly the Ergonomics technician's ergonomic skills, (CNC qualification level 4th — high-school upper education). The impact of these changes requires additional knowledge for the high school graduate of ergonomics mainly, but also other knowledge, which will help him to combine tasks in the job description, under normal work intensity and a scientific level of employment.

➤ **The adaptation of Ergonomics to the changes** that have taken place and will take place in our country due to scientific, technical, technological, economic, social, cultural, information, IT progress, etc., makes it research, link and adapt its content to the fast-moving evolution of these changes, which aim to: the development of electronic-based segments; e-government; research-production-innovation partnerships; public companies; the ICT (information and communication technology) expansion; the promotion of production systems; the promotion of innovation for competitiveness and new work places creation; complex skilled work increases; home working – teleworking proliferates and expands rapidly.

➤ **Changes in the content of occupations and the emergence of new occupations**, according to C.O.R, version updated on the 31st of December 2020, such as:

Environmental Systems Manager – COR code 325702

Expert / standardization specialist - COR code 325704

Environmental associate inspector – COR code 325705

Risk Management System Manager - COR code 325708

Occupational Safety and Health System Manager - COR code 325709

Working and safety conditions Technician - COR code 325722

It seems that the proportion of intellectual work in all areas of activity will continue to increase. The interest of adults increases in knowledge and professional training complementary to basic occupations and expertise with a positive impact on productivity growth, efficiency and effectiveness. The professional specialization of the profession/occupation of "Ergonomics Technician" is also included in this context.

➤ **Development and extension of digital technology in all economic and social structures:**

From enterprises, institutions, organizations, etc. to private houses in villages and communes, it demonstrates the need and opportunity to update the COR with the profession/occupation of "Ergonomics Technician". This requires the correlation of hardware, which is rapidly expanding compared to the software that is lagging behind, virtually the equipment of computers is not linked to the professional training for working on computers and at the same time to the profession of "Ergonomics Technician".

➤ **The emergence of novelty** in the alignment of the classification system to the Standard Systems. In order to make comparison between data on occupations of the Member States of the European Union and the rest of the world, the International Labour Organization has revised the version of the International Standard Classification of Occupations ISCO-88 by providing a new version, i.e. the revised **ISCO-08 classification** (Romania's Government, Decision no. 1.352 of December 23, 2010 (*republished*)) on the approval of the structure of Classification of the occupations in Romania- basic group level, according to International Standard Classification of Occupations - ISCO 08*), published in Official Gazette no. 300 of April 24, 2014.) required for the following reasons:

- increase in possibilities of knowledge, evaluation, comparison and communication of development and approach indicators;
- ensuring accurate and comparable information according to the same criteria and principles;
- acquaintance by users and the "Ergonomics Technician" of the classification system and the standards mentioned above.

Necessity and opportunity to introduce the profession of "Ergonomics Technician" into C.O.R.

By Government Decision No. 1352/2010 [8], the structure of the Classification of Romanian Occupations was approved beginning with 01.01.2011 on the basis of the International Standard Classification of Occupations — **ISCO 08** up to the

level of the major groups, followed by the approval of a new COR structure on occupation (six digits) by **ORDER No 1.832/856/2011, Issuer Ministry of Labour, Family and Social Protection (No 1832 of the 06th of July 2011), National Institute of Statistics (No 856 of the 11th of July 2011 published in THE OFFICIAL GAZETTE No 561 of the 8th of August 2011 [3].**

➤ **The necessity to modify and complete the C.O.R. with the "Ergonomics technician" occupation (6 digits) is justified as follows:**

The need for intervention and the provision of specific data and information which have arisen in connection with the development of certain micro-ergonomic activities which require macro-ergonomics to interfere in order to improve processes and products or increase productivity, as well as to ensure occupational safety and health, thus gradually entering the engineering. The Ergonomics has always had the tendency to focus on the projection of specific, individual jobs or on the resolution of particular problems, focusing exclusively on the human-machine interface, human-task, individual operator - the immediate working place or physical factors of the environment, for this affects the work performance in general and the occupational safety and health in particular. The Micro-ergonomics, the traditional classic ergonomics, has in view to design isolated, specific jobs or individual tasks and to solve some particular unique problems. Therefore, the ergonomic micro level interventions produce an immediate and obvious impact, providing some benefits to both the individual operator and management. Moreover, if in the case of micro-ergonomic interventions, the benefit cost ratio is evident for the high levels of management, the importance of the role of ergonomics becomes an integrated aspect of the workplace culture.

➤ **Opportunity to update the Classification of Occupations of Romania (COR) for the profession /occupation of "Ergonomics Technician".**

We can illustrate the interdisciplinary research *"Study on the organization of ergonomic work principles of the B II clothing workshop within the company "8 Martie" Piatra Neamț (today "EMA") - Studiu privind organizarea pe principii ergonomice a activității Atelierului de Confecții II B din cadrul Întreprinderii "8 Martie" Piatra Neamț* on 368 employees in 1989. The pilot study was interdisciplinary and the group of 36 specialists from various fields was made up of economists, engineers, architects, doctors, psychologists, sociologists, computer scientists, radiestists, masters and technicians. The study comprises 118 pages plus appendix. The research has been carried out using the systemic method, namely:

- **SUBSYSTEM I** – the ergonomic organization of the management of the clothing workshop B II. It has been divided into grade 1, grade 2, etc. subsystems until the problems end;

- SUBSYSTEM II – The overall ergonomic organization of the production program of the B II clothing workshop;
- SUBSYSTEM III – the ergonomic organization of the workforce at the workplace.

The final results were that the company met great success.

Before 1990 the Ergonomics was coordinated by the Ministry of Labour and the Council of Economic and Social Organization, which established County Cabinets throughout the country and in Neamț County (Director – PhD. EC. Susana Geangalău) practical works, studies and projects were developed on work organization based on ergonomic principles, which materialized in important socio-economic results, involving specialists interested in implementing measures and projects carried out on ergonomic principles, and on this occasion they acquired the ergonomic knowledge requested by each company. After 1990, new laws and regulations have been issued, which have passed over in silence an important and unique labor science that can make significant contributions to the local and national economy by increasing the workplace comfort, preserving people's health and increasing business profits, living standards, etc.

To be noted that the profession/occupation of “Ergonomics Technician” has never been included in the Classification of Romanian Occupations, although Ergonomics has a history in our country of over 40 years (and internationally history of over 65 years).

- **Local concerns** for preparing documentation for legislating the profession/occupation of “Ergonomics Technician”.

Between 2018-2021 the **ECOFORREST Association of Neamț –President of the NGO, PhD. EC. Susana Geangalău** in collaboration with the **Neamț Chamber of Commerce and Industry - President Mihai Apopii, General Manager Elena Aurora Emilia Miron** intensified the preparation of documentation by carrying out a series of actions, during the general meetings within this period, where the **ECOFORREST Neamț Association presented the need and importance of acquiring ergonomics knowledge** and its application in business, institutions, services and other organizations, a scientific field of practical application with multiple positive effects;

We have to mention that the **Neamț Chamber of Commerce and Industry** provided us with the necessary space for performing a training course for **the profession/occupation of ERGONOMIST**, carried out in a mixed, physical (more than 30 participants) and online system on the 28th of May 2021, which gathered, for the first time, business representatives, employees signed in the above mentioned course of ergonomist, thus opening the door to certifying the profession/occupation of “Ergonomics Technician”, respectively to promote the employees in companies and the future students, high school graduates or other similar forms of training, contributing to the progress of enterprises, institutions

and organizations, with an effect on productivity, economic efficiency and profit. Within the event three specialists in ergonomics introduced papers that had an impact on the participants and ended up with positive feedback. It is obvious that the competitive position of the new economic structures cannot be achieved without integrating ergonomics with the **profession/occupation of “Ergonomics Technician”** in the management of economic agents and organizations.

➤ **Ergonomic Standards in Romania provided by the Romanian Association for Standardization - ASRO**

In Romania the **Association for Standardization – ASRO** [7] is established as a national standardization body regulated. **ASRO is a full Member of the European Committee for Standardization (CEN) and the International Organization for Standardization (ISO)**. In the European context, **the certification** has become almost a prerequisite for any Romanian company, a guarantee of the quality of the products or services offered by the company. Thus more and more companies are certifying their **Quality Management System (ISO 9001), the Environmental Management System (ISO 14001), the Management System for testing laboratories (ISO 17025), the Occupational Health and Safety Management System (OHSAS18001)**. Most European Ergonomic standards reproduce the ISO standards, and some of them are also aligned in Romania. In Romania there are over 30 harmonized international and European standards on Ergonomics, of which we can exemplify:

- **ISO 10075-3:2004** - Ergonomic principles related to mental workload — Part 3: Principles and requirements concerning methods for measuring and assessing mental workload - in English
- **SR EN 29241-2 ISO 9241-2** – Ergonomic principles related to the office activity developed through video-terminals – in Romanian Part 2: – Guideline on work-related tasks
- **STAS 6909-75** – Organization and work rate setting – terminology in Romanian

➤ **DESIGN – Ergonomic design of the office of the ECOFOREST Neamț Association**

In order to correctly design the work area **in ergonomic terms**, we must present the activity of the **ECOFOREST Neamț Association**, which directly affects the Ergonomics of the workplace, but there are also general provisions and/or national standards which are inherent to each job. The field of activity of **the ECOFOREST Neamț Association** is as follows:

- Promotion of management adapted to company functions
- Training for professional initiation and retraining, qualification, specialization and further training, acquisition of key competences,

development of other forms of education to prepare adults for scientific, technical, economic and social research.

- Promotion of Ergonomics in economic and social activity, setting demonstrative examples with practical, functional and educational role.
- Development and implementation of European Finance projects and other sources. For the purpose of ergonomic design of the **ECOFORREST Association Office** (a completely simple space, which required redecoration by painting and finishing) there was set up a working group of four employees to fulfil an interior design project, before the start of the ergonomic observations:
 - PhD. ec. Susana Geangalău – Coordinator
 - Economist computer scientist - Geta Rotaru
 - Economist - Dorina Paleu
 - Manager Assistant - Daniela Ciubotariu – Texts drafting

Before starting the project, we made observations and tested various ideas and experiments to get a right concept and, on the other hand, the crystallization of the feeling and style that would be pleasant to others / customers. The ergonomic observations were made by the whole working group, were presented individually and, for each item or material needed to set up the office, a consensus was reached and a decision was made to acquire it, which we afterwards applied. The space itself has a total surface area of 26,28 m² divided into two distinct surfaces:

- **The entrance hall** – comprising storage spaces, closed cabinets 50 cm deep (which represent the width of a ring folder) up to the ceiling.
- **The work place with 4 workposts** (desk + ergonomic chair), metallic locker for money and valuable documents, mobile printer stand, coffee table and 4 guest seats.
- **The living plants** are an important aspect for the decoration of the ECOFOREST Neamț office, particularly because they bring a natural element into an artificial materials environment. Decorating the windowsill with green plants, variously coloured (pink bites, red roses, yellow orchids, etc.) using cylindrical and "V" shaped vases, fitted with the room itself and the window positioning, creates an enjoyable atmosphere.
- **The Colours** - help improve the working comfort, preserve health, increase productivity and efficiency.

Motto:

**”Let's enter the fascinating world of colours
That has always impressed MAN” [5]**

The knowledge of the affective colour characteristics allows making colourful pleasant arrangements that contribute to the creation of improved comfort conditions in the ECOFOREST Neamţ working space. The concept of functional colour refers to the use of colours in the process of employees' work to enhance work results, maintain health and good mood, as well as safety at work, with esthetical decorative and comfort role at work.

➤ **Techniques approached from literature [6]:**

- Funnel technique
- “Pie” chart
- Overall sensation/final image

By drafting an interior design project, we saw its affection, beauty and functionality. But as well as having to be pleasant for the eye, a person needs to feel comfortable and nothing should affect his health, whether we are talking about a laptop or the entire office. Of course, not everyone should agree with the actions we have taken, but ...how they say: **A nice office is the best part of life!**

Consequently, the studies, analyses, including the design project presented in this material fully justify the regulation of the profession of “**Ergonomics Technician**” by introducing it into the Classification of the occupations of Romania (COR) and the Classification of Economic Activities in European Community (CAEN), as well as the approval of the occupational standard on this basis by the National Qualifications Authority.

Enforcing Ergonomics as science and profession requires increased concerns and increased interest of professionals in relation to the scientific basis of human development in general, of our lives and work in particular.

"The mission of ergonomics is everlasting. It ends, abolishes itself when there are no people on earth. Until then, we need ergonomics and ergonomists today."

PhD. ec. Susana Geangălău [1]

c) **Descripton of occupation** - for revising the Classification of the occupations of Romania (COR) with the occupation of “**Ergonomics Technician**”, in accordance with Order no. 270/273 of the 12th of June 2002 issued by the Ministry of Labour and Social Solidarity and the National Institute of Statistics, regarding the approval of the procedure for updating the normative act of the Romanian occupations, Art. 8.

Duties and responsibilities

- **Responsibilities under CNC:** Self-administering within the

framework of guidelines for generally predictable but possibly changing work or study content; supervising the routine work of others, taking responsibility for evaluating and improving work or study activities.

➤ **Duties of the Ergonomics Technician**

- turns into practice, under the supervision of the ergonomist, some models of design of socio-technical or work systems.
- plan tasks and deals with ergonomics issues by providing the staff with the necessary information on the ways and the obtained results.
- applies the occupational safety and protection, environmental and emergency rules.
- plans objectives and ergonomic measures, in collaboration with the HR Department on improving the working conditions through ergonomic structure: identification of non-ergonomic workplaces, design and application of techniques and methods of analysis and ergonomic improvement of workplaces, application of research results and evaluation of the technical, economic and social results achieved, reflected in increased productivity, efficiency, effectiveness, raising of the living standard.
- has accurate knowledge of product quality compliance, integrating quality, ergonomics and environment, which implies a critical understanding of theories and principles in an interdisciplinary context.
- takes part into the analysis process of labour systems and socio-technical systems structures, as well as of characteristics of the two-sided work study: Study of methods and measurement of work and summary economic indicators.
- uses mathematical calculations and optimizations in work processes concerning: the determination of economic effort, time saving, work, productivity and profit growth, setting labour standards, analytical work norms and legislation, etc.
- takes part in pilot studies and simulations, spot-checks under justified circumstances, in the organization and ergonomic arrangements of the workplace, general working conditions, environmental factors, etc.

To support their operating philosophy, the Ergonomic technicians must:

- perform services only in their areas of competence;
- debate and issue statements in an objective and fair, true manner;
- act as professionals, promoters of change;
- maintain the efficiency parameters, safety, health and well-being;

- build their professional reputation on their own actions and not incorrectly compete.
- act in such a manner as to enhance honour, respect, loyalty, integrity and dignity of the profession;
- continue their professional career development and provide opportunities for the development of other Ergonomics technicians or Ergonomics practitioners.
- possess general skills in Units of competence on business planning, in dealing with ergonomic issues and have job-specific skills in: Ergonomic arrangements planning, ergonomic workplace organization: identification of non-ergonomic workplaces, application of techniques and methods of analysis, sustainable promotion of the internal ergonomic implementation system;

The operations, processes, methods and responsibilities reflect the work that an **Ergonomics Technician** performs in whichever enterprise, institution or organization independently of the activity field.

Work tools used:

- personal computer, screen, printer and accessories, scanner, keyboard, mouse, internet connection, Windows operating system, text and computing software, legislation, telephone, fax, flipchart, other logistical equipment
- measuring and control instruments/devices: meter, clock, timer, video cameras, computed stabilometre, digital tachistoscope, tremor-metre, manual coordination test device,
- ergonomics laboratory for testing and evaluating human potential equipped with: computed stabilometre, manual coordination test device, manual dexterity test device, etc.
- technical documentation, standards, ASRO standards, methods, techniques, working instructions, drawings, diagrams, etc.

Working programme:

- according to the provisions of the Labour Code
- depending on the activity structure, the program can be organized in 1-2 shifts
- 8 working hours a day

Activity environment

The Ergonomics Technician operates in a variety of areas or organizational units and in numerous situations.

Many other professions or careers (engineers, managers, system operators,

technical and operational standardizers, human resources or safety and organizational health professionals) are also working together to develop much more efficient and safer socio-technical systems.

The activity is carried out in **enclosed spaces** – offices equipped with ergonomic furniture, enjoyable atmosphere: Lighting and noise according to occupational health and safety regulations, air purity and microclimate conditions: Temperature, humidity, speed of air currents, heat radiation and odour.

The work can also be carried out in **open areas**, such as: the construction works where specific standards must be obeyed, the environment, circulation within the company, from a workplace to another, etc.

In various working environments where physical/intellectual demands are concerned.

Risks situations

Beginning with the need to develop a thorough study on the working system, specialists from the ECOFOREST Association of Neamț together with businessmen, those awarded the **Ergonomist** title (certified in July 2021) have identified – in order to legalize the profession of “**Ergonomics Technician**” with medium level studies – new dimensions of the profession on the **ergonomic relationship – occupational safety and health**, which requires a specific approach. Thus, the working system in which the worker interacts with work equipment in order to perform tasks/activities within a working environment is the place where a series of disturbances (hazards or risk factors) occur which may affect the overall balance. Apart from the usual dangers: exposure to noise, vibration, dust and chemical agents, UV radiation, extreme temperatures, etc. - which may affect the workers' safety and health, new risks have emerged in the working system, which are linked to the situations and dynamics of the labour market.

The labour market has been affected in recent years by demographic changes, technological changes leading to job insecurity, long-term work, increased work, the introduction of new modern and automatized equipment, the inadequate balance between professional and private life, etc. In this respect the “**Ergonomics Technician**” is involved in actions to prevent accidents at work and occupational diseases in order to avoid and combat occupational risks, to develop and implement accident prevention programs, to adapt work to mankind, taking into account the technology development and stage, appropriate training of workers. **The Ergonomics Technician** must also act for the application of the general principles established by **Law 319 / 2006 – the Law on Safety and Health at workplace** [10] and other legislation concerning **ergonomic matters** on professional training for medium level studies.

Requirements for the exercise of the occupation

Educational requirements: Graduates of upper secondary education (falling within CNC qualification level 4) and of the qualification course in the profession/occupation of **Ergonomics Technician**.

Medical requirements: Normal speech, normal visual and auditory acuity, good physical and mental health (according to the skills sheet issued by the occupational doctor, specific to the workplace).

Psychic requirements: Taking responsibility, being able to assess and make decisions, being a keen observer, analytical thinking, team work ability.

Training requirements

- Secondary education/high-school
- Training course with authorized provider of adult training according to the republished Government Ordinance No. 129/2000 for the pursuit of an occupation requiring an occupation level 4 qualification. Level 4 qualification according to the national qualifications Framework, equivalent to reference level 4 of the European qualifications Framework. For assignment to level 4 of CNC qualification (according to HG 918/20.11.2013 on the approval of the national qualification KCA — CNC — Appendix 2):
 - Graduates from upper secondary education (theoretical, technological or vocational schools) who have passed the baccalaureate exam and are awarded the baccalaureate diploma issued by the educational unit — theoretical, technological, vocational high school;
 - Graduates from upper secondary education (technological or vocational schools) who have passed the certification of the professional qualification and are awarded certificates of qualification and the descriptive supplement of the certificate issued by the educational unit — technological or vocational high school;
 - Upper secondary education graduates without a baccalaureate diploma who own a certificate of qualification/completion and the descriptive supplement to the certificate for the pursuit of an occupation requiring a level 4 qualification issued by an authorized vocational training provider.

Type of the qualification required for the pursuit of the occupation:

Certificate of qualification/graduation and the descriptive supplement to the certificate

Specialization obtained by means of the certificate of qualification/graduation in accordance with the law in force:

Ergonomics Technician

The interested persons can become **Ergonomics technicians** after completing a professional training course where they will be awarded a professional certificate of **Ergonomics Technician**.

Salary

- according to the employment contract, under the legislation in force
- the specific applicable regulatory framework will also be taken into account for the Ergonomics Technician remuneration.

Promotion at work

Promotion requires personal planning before climbing the hierarchical ladder:

- vision of jobs and what impact they have on career development
- assessment of the levels of competence in the concerned areas
- requires graduation of a professional course
- at the same time, it aims to acquire practices regarding professional affirmation
- promoting a new paradigm regarding the integration of organizational ergonomics in organizational management structure - modernization of the traditional Ergonomics.

The dynamics of the profession on the labour market

The dynamics of the profession of Ergonomics Technician on the labour market have a rapid and continuous development, driven by the changes driven by the results of scientific research, technical, technological, information, social, cultural, research by the capacity/creativity of inventions and innovations made by researchers concerned in Ergonomics. We refer to occupations superior to the Ergonomics technician: **The "Ergonomist"** (ergonomics systems, ergonomics product design expert, general ergonomics expert, ergonomics manager, etc.) as well as lower level occupations: Labour measurement operator, ergonomics practitioner, analyst on ergonomic workplace organization, etc., in the context of the Europe 2020 strategy:

The dynamics of the profession of the Ergonomics Technician in the labour market are aligned to the growth of the secondary and tertiary industries.

- the tertiary industry will cover three quarters of the occupied population.
- the labour market concerns employment and unemployment and quality of work, productivity, earnings and labour costs.

- promoting an entrepreneurial culture and SME development, which implies and the development of ergonomic culture.
- focus on flexibility in the labour market, as well as security through continuing vocational training for young people, women and the elderly.

The integration of all informational elements, collected in a coherent, unitary and comprised form, which reasoned the usefulness/necessity of introducing this profession into the C.O.R. was meaningful and on the superior institutions appreciation.

The favourable approval on the introduction of the occupation of Ergonomic Technician into the Classification of Occupations in Romania – No. 18744/18619/RG/1086/DPOCMP/ was given on the 28th of September 2021 by the Ministry of Labour and Social Protection - Department of Employment Policy, Skills and Professional Mobility in Romania.

4. Conclusions

The main ideas that have emerged from the research are:

(1) on the labour market, we have managed to take over from companies and organizations, ideas and, above all, convincing arguments about the need to legislate the profession of Ergonomics Technician in order for us to draw up the study to legislate this profession.

(2) the initiative and the idea that persuaded the ECOFOREST Association to legislate the profession of Ergonomics Technician was the one supported by the fact that from Micro-ergonomics we move to Macro-ergonomics. Micro-ergonomics is a helpful solution for long-term benefits, but a more comprehensive assessment of socio-technical systems is needed which can be achieved by leaping forward to macro-ergonomics. Micro-ergonomic interventions have significantly contributed to improving processes and products or increasing labour productivity. Of course, there is also the Mesoergonomics, defined as an open systemic approach to ergonomics theory and practice which study the relationships between variables of at least two different levels of a socio-technical system.

(3) another idea that has emerged from the research is that a part of the 2022 high-school graduates are going to attend an academic form, others would rather pursue a profession such as Ergonomics Technician, and we offer this possibility. But there are also adults who have graduated from their upper secondary education

later and prefer this profession. There are certainly other benefits, for example, relating to the assessment of professional knowledge which raises the level of education, reducing unemployment, etc.

(4) The creation of this profession/occupation will bring added value to the progress of the Ergonomics, with a positive impact on business and enterprises, with a multiple effect on the indicator of efficiency/effectiveness and productivity that ensures the sustainability, stability and growth of well-being, and the quality of life in Romania.

REFERENCES

- [1] Geangalău, S. (coordinator), Răzeşu, V., Țepeş Ghibosu, I., Paleu, D., Applied ergonomics in the system MAN-COMPUTER-ENVIRONMENT, Tehnopress Publishing House, Iaşi, 2012.
- [2] Ministry of Justice- National Office of Trade Register, Code of the Activities in the National economy (CAEN) of România.
- [3] Ministry of Labor, Family and Social Protection no. 1832 of July 6, 2011, National Institute of Statistics no. 856 of July 11, 2011; Order no. 1.832/856/2011 on the approval of the Classification of the occupations in Romania- occupation level (six characters), published in Official Gazette no. 561 of August 8, 2011.
- [4] Ministry of Labor and Social Solidarity No. 270 of June 12, 2002, National Institute of Statistics, No. 270 of June 12, 2002, National Institute of Statistics No. 273 of June 18, 2002 - Order No. 270/273 of June 12, 2002 on the approval of the Procedure for updating the nomenclature Classification of occupations in Romania, published in Official Gazette no. 531 of July 22, 2002.
- [5] Mureşan, P., Colour in our life, Ceres Publishing House, Kaleidoscope collection, Bucureşti, 1988.
- [6] Ramstedt, F., Guide of interior design, translation from Swedish language by Iulia Dromereschi. Editors: Muraru, C., Dragomir, S., Publica Extra Publishing House, 2020.
- [7] Romanian Standardization Association, ASRO, Ergonomic standards of Romania utilized in the process of ergonomics implementation.
- [8] Romania's Government, Decision no. 1.352 of December 23, 2010 (*republished*) on the approval of the structure of Classification of the

occupations in Romania- basic group level, according to International Standard Classification of Occupations - ISCO 08*), published in Official Gazette no. 300 of April 24, 2014.

- [9] Romania's Government, Ordinance no. 129/2000 of August 31, 2000 *** Republished on the professional formation of the adults, republished in Official Gazette of Romania, Part I, no. 110 of February 13, 2014.
- [10] Romania's Parliament, Law no. 319 of 14 July 2006 of occupational safety and health, published in the Official Gazette No. 646 of July 26, 2006