Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 23, Issue 2, 2023
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ASSESSING THE STATE OF FERTILITY (QUALITY) OF THE SOILS FOR SUSTAINABLE AGRICULTURE IN REMETEA MARE, TIMIS COUNTY, ROMANIA

Casiana MIHUȚ, Nicoleta MATEOC-SÎRB, Anișoara DUMA COPCEA, Simona NIȚĂ, Iaroslav LAȚO, Valeria CIOLAC, Antoanela COZMA, Adalbert OKROS

University of Life Sciences "King Mihai I" from Timișoara, 300645, 119 Calea Aradului, Romania, Phone: +40256277001, Fax:+40256200296, E-mails: casiana_mihut@usab-tm.ro, nicoletamateocsirb@usab-tm.ro, anisoaradumacopcea@usab-tm.ro, simona_nita@usab-tm.ro, valeriaciolac@usab-tm.ro, iaroslav.lato@usab-tm.ro, cozma@usab-tm.ro, adalbertokros@usab-tm.ro

Corresponding author: casiana_mihut@usab-tm.ro; adalbertokros@usab-tm.ro

Abstract

The values obtained give us a series of information related to the factors present in the soil, factors that affect or limit the fertility and quality of these soils, such as: humus content, reaction, degree of settlement, etc. whose knowledge is particularly important because a series of improvement or limitation measures can be taken in time allowing the practice of sustainable agriculture. In the current context of climate change, both soils and crops are particularly vulnerable to a series of changes and environmental factors. In this context, the sustainable use of soils aims at improving soil quality and obtaining higher and qualitatively significant productions. This can only be achieved by knowing soil physical, physical-mechanical and chemical properties. This paper shows a series of soil properties, such as texture, densities, porosities, pH, humus content, total nitrogen content (%), mobile phosphorus (ppm), mobile potassium (ppm) content and soil settlement degree (%) in the seven types of soil identified within the studied perimeter.

Key words: *assessment, soil quality and fertility, sustainable agriculture, soil properties, limiting factors*

INTRODUCTION

The basis of this study is the hypothesis that "healthy soils provide an optimal environment for soil organisms that stimulate the physiological and biochemical response of plants to stress and climate change" [15, 18].
One of the main agricultural problems worldwide is the decrease in fertility and, implicitly, in soil quality, mainly because of the reduction of soil biodiversity and of the content in organic matter, nutrients and water [7, 16].
Agricultural soils are particularly susceptible to this problem, as they rely on simplifying the relationships between plant and the other components of the natural habitat, which should facilitate the control of agricultural ecosystems. Most studies conducted over time claim that agricultural intensification and agricultural land conversion lead to a decrease in soil organic matter (SOM), leading to the loss of soil biodiversity [12, 24]. Also, the widespread use of pesticides can have, directly or indirectly, a negative effect on soil biodiversity, but the data obtained so far by different authors have led to contradictory results [11, 19].
SOM, especially through its stable fraction (humus), plays an important role in climate change mitigation and adaptation [9]. Both the amount and the types of SOM are determined mainly by the continuous chemical and physical action of soil microorganisms. In the process of transformation and decomposition of MOS, an essential role is played by soil fauna and microorganisms [4, 6].
Agricultural lands and crops are vulnerable to climate change, changes that manifest themselves on the environment, with increasingly obvious repercussions in the near future [13].
Many crops are at risk due to the reduction of the amount of precipitation and its uneven

distribution during the growing season, factors that will contribute in the near future to an increase in aridity and desertification of soils, ultimately contributing to a degradation of the structure of the soil and the content of organic matter in the soil, of micro and macronutrients, elements with an essential role in the growth and development of plants [2, 10, 20].

Intensive agriculture involves carrying out a greater number of soil works, which over time degrades the soil, affecting the stability of structural microaggregates, elements that play a key role in the formation of organic matter and support long-term carbon sequestration, being more stable than macroaggregates [6].

This, leading to an increase in the use of mineral fertilizers and pesticides, requires continuous and energetic tillage to be able to replace the activity of the soil fauna and the loss of SOM. [5, 19].

The studied area is located in the centre of Timiş County, on DN 6, at a distance of 12 km from the Municipality of Timişoara and 47.7 km from the Municipality of Lugoj.

The studied area covers an area of 7,289 ha, of which 5,956 ha is agricultural land. Its relief is represented, in general, by plains (the Tisa Plain) and hills (the Western Hills) [13, 22].

The hilly sector occupies the part located NE of the village of Ianova, in the form of a succession of hills, 300-400 m wide, slopes with 3-20% inclination that, sometimes, fall in steps towards the meadows and micro-meadows of the erosion valleys, which reach widths between 500-600 m [14, 21, 22].

The altitude of the hills is between 150-200 m; the plain area, which occupies most of the territory, has an altitude of 75-120 m in the plain sector and 80-90 m in the meadow sector, the latter being interspersed with numerous deserted meanders, with marshy depressions and shingles which provide, both through the soils and the presence of shallow groundwater, good lands for the practice of agriculture [1, 19].

The climate, moderately temperate-continental, can be characterized as a lowland climate, at the limit of interference between the western subtype with oceanic nuances and the Banat subtype with sub-Mediterranean nuances [8, 14].

The average annual temperature is 10.8°C, and the average annual amount of precipitation is 600.4 mm (Timişoara Meteorological Station), with the mention that, if there is a deficit of rain moisture in the summer period, surpluses of water are recorded during the rest of the year both in the soil and on its surface, with negative influences on the balanced development of agricultural crops [13, 23].

MATERIALS AND METHODS

For this study, data from the OSPA Timişoara, from previous research, from specialized literature, and especially data from own observations made in the field and in the laboratory were used [17].

A series of physical, physical-mechanical and chemical analyses of the seven identified soil types were made [3].

Profiles were dug and soil samples were collected in a disturbed structure to determine the physical, physical-mechanical and chemical indices of the soils.

The measurements were made according to the current methodology.

The granulometric composition of each type of soil was determined and the texture class, density and apparent density values were determined; porosities and degree of settlement of each soil were calculated, as well as humus content, soil reaction, total nitrogen content (%), mobile phosphorus content (ppm), and mobile potassium content (ppm) over the 0-20 cm profile.

Depending on the values of these indices (physical, physical-mechanical and chemical), on the presence of phreatic or stagnant water in the soil, the main limiting factors were established, which limit to a lesser or greater extent, depending on their presence in the soil and on the degree of manifestation, soil fertility and quality [8].

RESULTS AND DISCUSSIONS

The total area of Remetea Mare is 7,289 ha, of which 5,956 ha (81.71%) is agricultural land,

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 23, Issue 2, 2023
PRINT ISSN 2284-7995, E-ISSN 2285-3952

586 ha (8.04%) is occupied by forests and 747 ha (10.25%) have other categories of use as presented in Table 1 and Figure 1.

Table 1. Land use in Remetea Mare

Land use	Ha	%
Arable	5,956	81.71
Grasslands and haymaking fields	168	2.30
Orchards	32	0.44
Forest	747	10.25
Forested grasslands	386	5.30
Total	7,289	100

Source: Own calculation.

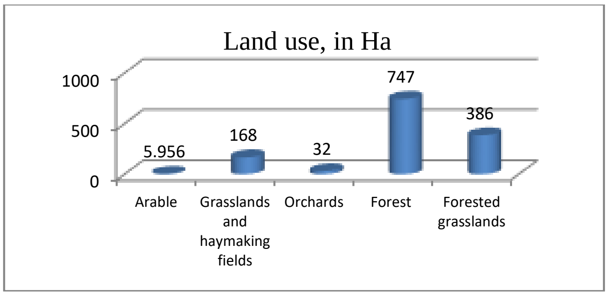

Fig. 1. Land use in Remetea Mare
Source: Own calculation.

Within the locality, there are 122 units with legal personality, in different fields of activity, most of them agricultural. The most common crops are represented by wheat, maize, followed by soy, rapeseed, barley, oats, alfalfa, potatoes, fruit trees – among which walnut, plum, apple and cherry prevail (Photo 1 and 2).

Photo 1. Wheat crop
Source: Original photo.

Photo 2. Corn field
Source: Original photo.

The genesis and evolution of soil types are directly related to climate and vegetation conditions, to the natural subsidence of the relief, to the influence of groundwater, as well as to human intervention. Currently cultivated plants cover almost the entire range of agricultural crops practiced in the Western Plain of Romania.

The grouping of land units has led to the identification of the dominant types of soils shown in Table 2 and Figure 2.

Table 2. Soil classes and types identified in Remetea Mare

Soil class	Soil type	Area (%)
Cernisols	Phaeozem	38.3
Luvisols	Luvisols	8.3
Cambisols	Eutricambosols	9.6
Hydrisols	Gleysols	19.2
Hydrisols	Stagnosols	4.3
Vertisols	Vertosols	8.4
Protisols	Aluviosols	11.9

Source: Own calculation.

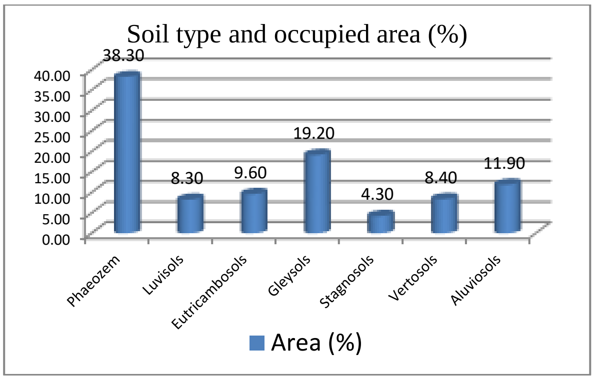

Fig. 2. The type of soil in Remetea Mare and the area in %
Source: Own calculation.

Because of the mineralization of the largest part of the annual organic remains in the upper part of the soil, a small amount of humus is formed and, as a result, the colour of the upper horizon formed in the soils found in the studied area is brown, which gives rise to the formation of an Ao – A ochric soil layer: this has led to the formation and evolution of most of the soils encountered (Luvisols, Eutricambosols, Gleysols, Stagnosols, Vertosols and Fluvisols).

Only to a lesser extent, on flat surfaces, with a more pronounced accumulation of organic matter, a dark, blackish-coloured soil layer was formed, which has given rise to a soft Am – A mollic soil layer, characteristic of Phaeozems, soils that occupy 38.3% of the arable area.

Following laboratory analyses, the following physical properties of these soils were determined (Tables 3 and 4 and Figures 3, 4 and 5).

Table 3. Granulometric composition of the soils from the Remetea Mare locality

Soil type	Coarse sand (2.0-0.2 mm) %	Fin sand (0.2-0.02 mm) %	Dust (0.02-0.002 mm) %	Clay (< 0.002 mm) %	Texture class
Phaeozems	2.8	40.0	28.9	28.3	LL
Luvisols	2.8	37.9	32.0	27.3	LL
Eutricambosols	6.90	39.20	32.70	21.20	LP
Gleysols	0.3	30.6	34.8	34.3	TT
Stagnosols	0.8	29.1	30.6	39.5	TT
Vertosols	0.2	9.4	14.8	75.6	AF
Aluviosols	33.3	30.4	16.1	20.2	SG

Source: Own calculation.

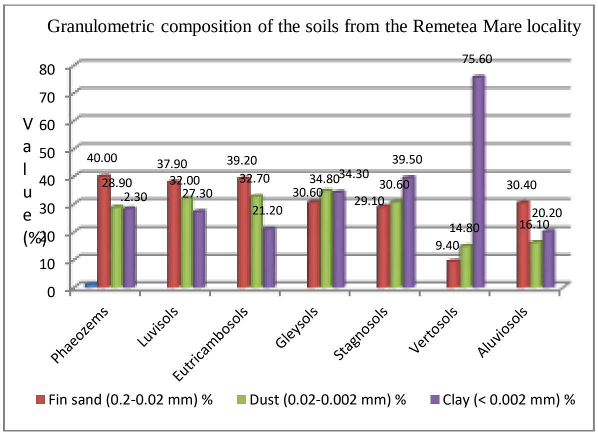

Fig. 3. Granulometric composition of the soils from the Remetea Mare locality
Source: Own calculation.

The granulometric composition of the soils is loamy (LL) in Phaeozem and Luvosol, loamy-dusty (LP) in Eutricambosol, medium-fine (TT) in Gleysol and Stagnosol, clayey-fine (AF) in Vertosol and coarse (SG) in Alluvial soil, respectively.

The biggest problems, because of the fine and coarse textures, are in Vertosol and Fluvisol; in Gleysol and Stagnosol, because of the presence of shallow groundwater and of the pooling of water from precipitation, respectively, have a low natural fertility.

Table 4. Physical and physical-mechanical properties of the soils in Remetea Mare

Soil type	Density (g/cm^3)	Apparent density (g/cm^3)	Total porosity (%)	Aeration porosity (%)	Subsidence degree (GT%)
Phaeozems	2.68	1.39	48.13	16.20	+5
Luvisols	2.69	1.63	39.41	0.34	24.53
Eutricambosols	2.58	1.67	35.3	8.84	28.0
Gleysols	2.45	1.39	39.38	10.16	26.10
Stagnosols	2.67	1.62	38.32	2.58	20.26
Vertosols	2.43	1.29	47.0	1.59	22.54
Aluviosols	2.62	1.50	43.10	19.85	11.10

Source: Own calculation.

The physical properties of soils are also influenced by soil texture, which leads to an increase in density and apparent density values in the case of Phaeozems, Luvisols, Eutricambosols, Stagnosols and Vertosols whose total and aeration porosities fall well below 40% total porosity (35.3-39.41%) at very low values of aeration porosity, values ranging from 0.345% in Luvisols to 19.85% in Fluvisols.

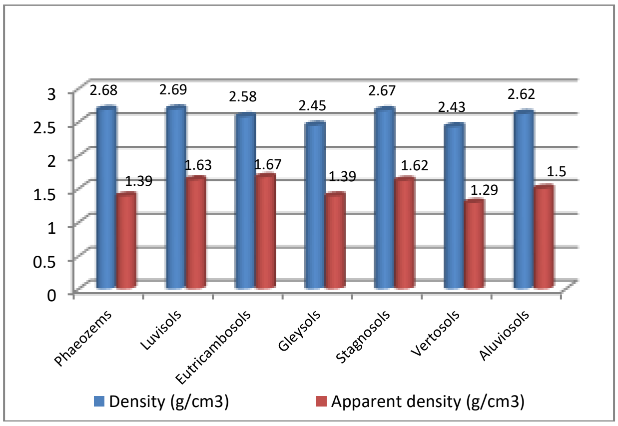

Fig. 4. Physical properties of the soils in Remetea Mare
Source: Own calculation.

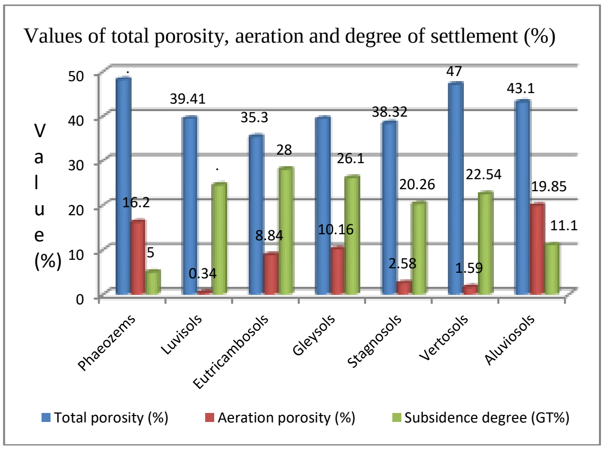

Fig. 5. Physical and physical-mechanical properties of the soils in Remetea Mare
Source: Own calculation.

The soils with the highest degree of subsidence are Luvisols with 24.53%, followed by Gleysols with 26.10% and Eutricambosols with 28.0%. Fluvisols with 11.10% and Phaeozems, which, at a depth of 0-20 cm, show a degree of subsidence of only 5%, are at the opposite pole.

Table 5 and Figure 6 and 7, shows the main chemical properties of soils.

Table 5. Chemical properties of the soils in Remetea Mare

Soil type	H_2O pH	Humus (%)	Total nitrogen (%)	Mobile phosphorus (ppm)	Mobile potassium (ppm)
Phaeozems	6.86	3.84	0.350	117.4	182
Luvisols	5.29	1.61	0.116	11	87
Eutricambosols	6.45	2.43	0.140	25	350
Gleysols	6.82	5.75	0.258	40	130
Stagnosols	6.18	4.27	0.208	38	180
Vertosols	6.50	3.41	0.308	67	320
Aluviosols	5.55	2.79	0.259	15	70

Source: Own calculation.

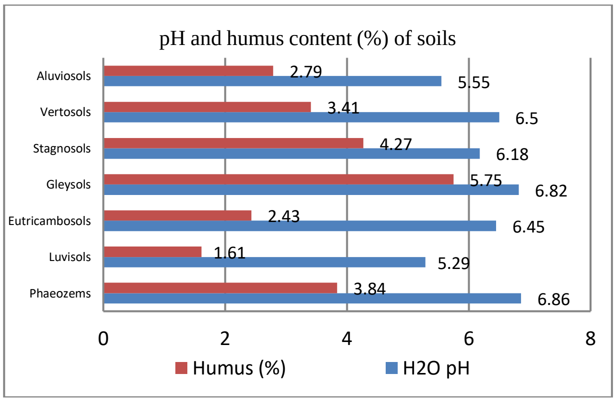

Fig. 6. pH and humus content (%) of soil from Remetea Mare
Source: Own calculation.

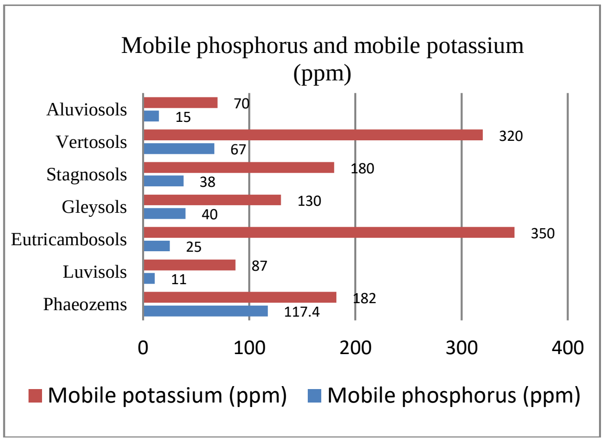

Fig. 7. The content in mobile phosphorus and mobile potassium (in ppm) of soils from Remetea Mare
Source: Own calculation.

Data presented above show that Luvisols and Fluvisols have a low pH, i.e., a rather high degree of acidification, which limits their fertility (quality) and their use as agricultural land. On these soils, it is recommended to amend the soil with calcium-based amendments to reduce their acidity level, thus increasing their quality and fertility. The humus content of the soils is between 1.61% in Luvisols and it reaches 4.27% in Stagnosols and 5.75% in Gleysols, respectively, which are also the soils that raise the most problems from a qualitative point of view. Vertosols, whose content in humus is 3.41%, being medium supplied in humus, also have low fertility because of the presence of the clay fraction in high proportions (75.6%), which makes them unsuitable for fruit trees and hoeing plants where soil humidity is not constant. In the years when there with a shortage of water in the soil, very large cracks (more than 2 cm in diameter) appear on the surface of these soils, which often crack the roots of plants, reduce capillarity and increase the degree of subsidence.

The total nitrogen content is between 0.116% in Luvosol, 0.208% in Stagnosol and 0.350% in Phaeozem, respectively. The most abundant total nitrogen content is in Phaeozems, followed by Vertosols and Fluvisols. Mobile phosphorus content has values between 11 ppm in Luvisols and 117.4 ppm in Phaeozems, while mobile potassium content is between 70 ppm in Fluvisols, 320 ppm in Vertosols and 350 ppm in Eutricambosols, respectively.

These results show that, in general, soils have a different production capacity, this diversity being influenced by a series of limiting factors, the most important of which are soil reaction, humus reserve, excess surface and water table moisture, fine texture, land slope, and degree of subsidence.

These limiting factors that obstruct the optimal exploitation of the soil are represented differently and affect the quality and fertility of the soils in a different way: the phenomenon of acidification, because of the reaction of the soil, affects 83.97% of the agricultural area of the locality (moderate 48.3%, reduced 35.67%), the humus reserve in the proportion of 55.1% (moderate 18.2%, reduced 36.9%), the degree of subsidence of 87.56% (severe 67.06%, moderate 20.5%), the fine texture (reduced 62.2%), the land slope, 13.8% (moderate 4.1%, reduced 9.7%), the excess groundwater 56.67% (very severe 18.3%, severe 26.8%, moderate 9.3%, reduced 2.27%) and surface water 53.89% (very severe 8.3%, severe 21.6%, moderate 15.8%, reduced 8.19%).

Depending on these limiting factors and on their properties, the soils encountered within the studied area were classified into the following quality (fertility) classes for the "arable" use category: class II 583 ha (6.7%), class III 3,744 ha (43.0%), class IV 3,234 ha (37.1%) and class V 1,152 ha (13.2%).

As far as the restrictive elements mentioned are concerned, periodic amendments with calcium, deep loosening, improving fertilizing, ploughing along the level curve (in the hill area) and hydro-ameliorative works for aiming at drying and evacuating the excess groundwater and rainfall water are necessary on a case-by-case basis (in low meadow areas).

CONCLUSIONS

The content of the soil in nutrients, the pH, the granulometric composition (texture), the structure, the content in humus, the state of gleization, stagnogleyzation, the degree of subsidence, etc. particularly influence the life of the agroecosystems, all together representing the expression of the long-term interaction between vegetation and environmental conditions. The degree of soil supply with nutrients is of particular importance for the structure and productivity of the crops: the productive potential of the phyto systems can be valued, under normal conditions, by the supply with nutrients and water.

In different pedological and climatic conditions, the agricultural production that is obtained in an intensive agriculture, requires a detailed knowledge of the soil properties and the climatic, anthropogenic and ecological factors.

The soil is constantly subject to a complex of factors, represented by light, heat, precipitation, relief, lithology, hydrology, biological, physical, chemical, water properties, etc., factors that change in time and space and that are found in the productive capacity of agricultural lands, respectively in the degree of fertility (quality) of the soils. Choosing the most appropriate exploitation technologies and taking conservation and improvement measures, by applying fertilizers and amendments, in appropriate doses, lead to an increase in productivity.

The natural fertility of the soil is an important factor in the formation and evolution of the soils in this area. The agricultural lands in that area have always been fertile, and provided food for people and animals and the sale of agricultural products (processed or as raw material). Since ancient times, the land of this area has been fertile, providing food for both humans and animals, and for the marketing of products, either processed or as raw materials.

The fertility of Fluvisols is extremely varied from one soil subtype to another or from one variety to another. The calculation of average values cannot certify the state of evolution or existence of the soils at this stage. In general, and excluding the entic subtypes, alluvial soils have a satisfactory, in some cases even good, quality. For example, batigleyc Fluvisols with balanced granulometric composition are classified in class II.

The fertility of eutricambosols is medium, but it can be increased through proper fertilization and quality soil works.

The fertility of gleysols: in principle, the excess of moisture limits agricultural crops, but after hydro-ameliorative works, they can be cultivated successfully.

The fertility of vertosoils is quite low, because of the presence of sliding faces on the structural elements.

ACKNOWLEDGEMENTS

This paper is published from the project 6PFE of the University of Life Sciences "King Mihai I" from Timisoara and Research Institute for Biosecurity and Bioengineering from Timisoara.

REFERENCES

[1] Bacău, C., Mateoc-Sîrb, N., Ciolac, R, Mateoc, T., Teodorescu, R.I, Tabără, V., 2021, Study on the production and use of biomass energy in the Timis County, Rom Biotechnol Lett., 26(2):2434-2440.

[2]Borza I., 1997, Soil improvement and protection (Ameliorarea şi protecţia solului), Mirton Pub;ishing House, Timişoara, p. 175-179.

[3]Crista, F., Radulov, I., Sala, F., Lațo, A., 2011, Agrochemistry. Methods of analysis (Agrochimie. Metode de analiză). In Romanian. Eurobit Publishing House, Timişoara, pp. 63-67.

[4]Duma Copcea, A., Mihuț, C., Niță, S., Niță, L., 2016, Distribution of 1st level monitoring sites per evaluation classes of some hydro-physical features of the soils within the commune of Sag, Timis county, Romania, Scientific Papers-Series Management Economic Engineering In Agriculture And Rural Development, Vol. 16(1), 139-141.

[5]Duma Copcea, A., Mihuț, C., Niță, S., Niță, L., 2016, Distribution of 1st level monitoring sites per evaluation classes of some physical features of the soils within the commune of Sag, Timis county, Romania, Scientific Papers-Series Management Economic Engineering In Agriculture And Rural Development Vol. 16(1), 135-137.

[6]Filser, J., Faber, J. H., Tiunov, A. V., Brussaard, L., Frouz, J., De Deyn, G., Uvarov, A. V., Berg, M. P., Lavelle, P., Loreau, M., Wall, D. H., Querner, P., Eijsackers, H., Jiménez, J. J., 2016, Soil fauna: Key to new carbon models. Soil, 2(4), 565–582. https:// doi.org/10.5194/soil-2-565-2016.

[7]Ianoş, Gh., Goian, M., 1992, Influence of the agriculture systems on the soils quality from Banat. Problems of Theoretical and Applied Phytotechnique in Banat (Influenţa sistemelor de agricultură asupra calităţii solurilor din Banat. Probleme de agrofit. teor. şi aplic.), ICCPT Fundulea, Vol. 14(3-4), pp. 116-119.

[8]Ianoş, Gh., Puşcă, I., Goian, M., 1997, Banat soils - natural conditions and fertility (Solurile Banatului-condiţii naturale şi fertilitate), Mirton Publishing House, Timişoara, pp. 96-98.

[9]Intergovernmental Panel on Climate Change, IPCC, https://www.ipcc.ch/2019/, Accessed on December 10, 2022.

[10]Matson, P. A., Parton, W. J., Power, A. G., Swift, M. J., 1997, Agricultural intensification and ecosystem properties. Science, 277(5325), 504–509. https://doi.org/10.1126/science.277.5325.504

[11]Mihuț, C., Ciolac, V., Moatăr, M., Mircov, V., Okros, A., 2019, Contributions to the use of modern technologies to optimize the recording of the agricultural area cultivated in a conventional system on the territory of Târnova commune, Arad County, Romania. International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, 2019. https:// doi.org/10.5593/sgem2019/2.2/S11.093.

[12]Mihuț, C., Duma-Copcea, A., Mihuț, A., 2018, Evaluation of the production capacity of agricultural land from the perimetre of the Periam locality, Timis County for its sustainable use. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 18(1), 253-256.

[13]Mircov, V.D., Okros, A., Mihuț, C., Borcean, A., 2019, Extreme meteorological phenomena recorded during winter 2009 - 2019 in Timisoara, Timis county. International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM.https://doi.org/10.5593/sgem2019/4.1/S19.121.ISSN:13142704.

[14]Munteanu, I., Munteanu, R., 1998, Timiș Monography, Marineasa Publishing House, Timișoara, 10, 27-28.

[15]Niță, L., Grozav, A., Rogobete, Gh., 2019, Natural and Anthropic Soil Acidification in the West of Romania, Chemistry Journal, Vol. 70(6), 2237-2240.

[16]Okros, A., 2015, Fertility status of soils in western part of Romania. Journal of Biotechnology, Vol. 208(S63): 3-14.

[17]Office of Pedological and Agrochemical Studies OSPA, Timis, 2022.

[18]Pinstrup-Andersen, P., Pandya-Lorch, R., 1998, Food security and sustainable use of natural resources: A 2020 vision. Ecological Economics, 26(1), 1–10. https://doi.org/10.1016/ S0921-8009(97)00067-0.

[19]Silva, V., Mol, H. G. J., Zomer, P., Tienstra, M., Ritsema, C. J., Geissen, V., 2019, Pesticide residues in European agricultural soils – A hidden reality unfolded. Science of the Total Environment, 653, 1532–1545.https://doi.org/10.1016/j.scito tenv.2018.10.441

[20]Sofo, A., Zanella, A., Ponge, J.-F., 2019a, Soil quality and fertility in sustainable agriculture, with a contribution to the biological classification of agricultural soils. Journal Soil Use and Management. Vol. 38(2), 1085-1112, https://doi.org/10.1111/sum.12702

[21]Ţărău, D., Niţă, L., David, Gh, 2020, Soil Science in the 3rd Millennium (Ştiinţa solului în mileniul III), Banat Agriculture Journal (Agricultura Banatului), 4(145): 25-38.

[22]Țărău, D., Luca, M., 2002, Panopticon of Banat communes fro pedological perspective (Panoptic al comunelor bănățene din perspectiva pedologică), Marineasa Publishing House, Timișoara, p. 181.

[23]Vass, H., Mănescu, C., Murg-Sicoe, O., Mateoc, T., Mateoc-Sîrb, N., 2021, Study on climate change issue and environmental degradation in Romania, Management Agricol, Lucrări Științifice Seria I, Vol. 23(2), 89-96.

[24]Vintilă, I., Borlan, Z., Răuţă, C., Daniliuc, D., Ţigănaş, L., 1984, Agrochemical situation of Romania's soils. Present and future (Situatia agrochimica a solurilor din România. Prezent si viitor), In Romanian. Ceres Publishing House, Bucuresti, pp.43.