EFFICIENT USE OF AGRICULTURAL LAND IN THE CURRENT CONTEXT OF CLIMATE CHANGE

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Abstract. *The paper refers to the soils in Giarmata, Timiș County, the occupied areas and the way of use, presenting the main limiting factors and the classification in quality and fertility classes of the main agricultural crops in the current context of climatic changes. The objectives referred to: description and presentation of the soil and climatic conditions of the area; presentation of the main soil types in the Giamata area and description of those taken in the study; listing the main classes of quality, respectively fertility; determination of limiting factors and description of the processes taking place; description of soil types on which the research has been carried out; classification of land in quality classes according to the credit marks obtained for the main agricultural crops (maize, wheat, barley and sunflower) during 2021-2022. The studied material refers to the identification, presentation and description of the main types of soils identified in this area, namely: preluvosols, alluvials, chernozems, vertosols, pelosols, gleysols and stagnosols. Giarmata commune is located in the central-northern part of Timis County, at a distance of 11 km from Timişoara and 1.3 km from Timişoara International Airport. The locality is situated at an altitude between 100 and 150 m, with a weak fragmentation and low relief energy, occupying a total area of 7150 ha, of which 6292 ha represents agricultural land and 43.5 ha forest. The studies were carried out on 158 ha, divided into 5 plots, with areas between 22 and 43 ha. The main crops were maize (83 ha), wheat (44 ha), sunflower (20 ha and barley (8 ha). The lowest average temperature was recorded in February, 2021, namely -2.0°C. The absolute minimum temperature during the same period was -27.2°C on 16 February 2021.*

Keywords*:agricultural land, soil type, limiting factors, pedological processes*

INTRODUCTION

Dealing with the study of soil, as a living environment for plants, pedology has a very important role in the development of agricultural production. The process of obtaining agricultural products is directly related to the soil, which in agriculture is the main means of production (POSEA GH., 2009; ȚĂRĂU D., BORZA I., DUMITRU M., CIOBANU C., 2007).

The soil, as a means of production in agriculture, presents certain particularities, which distinguish it from other means of production. Thus, soil is a natural means of production, which forms and evolves on the surface of the land, over time and under the influence of environmental conditions (BUCUR N., LIXANDRU GH., 1997). Also, unlike other means of production that wear out through use, the soil, if used rationally, not only does not decrease its fertility, but, on the contrary, can increase it (GOIAN M., IANOȘ GH., RUSU I., 1983; URUIOC STELA.2001).

Agricultural practice shows that, indeed, production capacity and therefore yields can be increased with the help of certain measures, such as: the use of advanced high-tech machinery and tools; use of fertilizers, amendments and control substances; by carrying out works of irrigation, drying, drainage, damming, preventing and combating erosion; by improving man's work and knowledge; by applying research results in scientific research, etc. (BRADY N.C., WEIL R.R., 2003).

The results of research in the field of soil science provide in decades, especially many, very important for the improvement of the latest technologies and plant cultivation, and aim at the direction of the plant nutrition process, the control of the state of fertility and pollution. ,

through the physico-chemical analysis of the soil and the plant, etc.(MIRCOV, V.D., OKROS, A., MIHUȚ, C., BORCEAN, A., 2019).

The problems of raising the state of soil fertility must be viewed both from the perspective of the current requirements for increasing production, improving the quality of primary production (and not only) and increasing the yield in agriculture, as well as through their harmonious combination. with the main agricultural parameters. physico-chemical of the soil, with which they are in close interdependence (LIXANDRU GH., PETRESCU S. ȘI COLAB., 1984).

Increasing fertility status is a complex problem that must be treated as one of the practical applications of general systems theory (BORLAN Z., HERA C., 1994; DAVIDESCU D., DAVIDESCU VELICICA, 1983). Establishing the nutritional balance, as well as the interconditioning, within the soil-plant relationship, requires knowing the meaning of some fundamental notions, which refer to the physico-chemical properties of the soil.

Benefiting from scientific achievements in the field of agrochemistry, chemistry, biochemistry, physiology and other branches of science, pedology, as an interdisciplinary science, explains numerous processes and phenomena in the soil that are reflected in the plant, closely related to plant nutrition and crop formation as well. and the objective causes that prevent the growth and development of plants, with the indication of measures to rehabilitate the problem (DUMA COPCEA ET AL., 2021; FLOREA N., 1982; RADULOV ISIDORA, 2007).

MATERIAL AND METHODS

The paper presents the soils in Giarmata town, Timiș county, the occupied surfaces and their use, the main limiting factors and the quality and fertility classification of the main agricultural crops in the current context of climate change (MIRCOV, V.D., OKROS, A., MIHUȚ, C., BORCEAN, A., 2019; MIHUȚ C., NIȚĂ L., 2028).

Proposed objectives: description of the pedological and climatic conditions of the area; the presentation of the natural setting of Giarmata commune; the presentation of the main types of soil in the Giamata area and the description of those studied; the presentation of the climatic conditions of the analyzed period (2021-2022) and the crop situation; enumeration of the main quality classes, i.e. fertility, in which the lands of the locality are classified in general; establishing the limiting factors and describing the processes taking place; the description of the types of soil on which the research was carried out and the classification of the land into quality classes according to the credit ratings obtained for the main agricultural crops (corn, wheat, barley and sunflower) in the period 2021-2022 (MIHUȚ CASIANA, LAȚO I., 2007; OBREJANU GR. ȘERBĂNESCU I., CANARACHE A., MANUCĂ O., 1964).

The studied material is represented by the identification, presentation and description of the main types of soils identified in this area, namely: preluvosols, alluviosols, chernozioms, vertosols, pelosols, gleosols and stagnosols (FLOREA N., 1964; FLOREA N., MUNTEANU I., 2012; IANOȘ GH., GOIAN M., 1995).

RESULTS AND DISCUSSIONS

Located in the central-northern area of Timiș county (45°83' north latitude and 21°32' east longitude), the town of Giarmata, has been attested since 1332 and is located at a distance of 11 km from the municipality of Timișoara and 1, 3 km from the "Traian Vuia" International Airport in Timisoara. It occupies an area of 7150 ha, of which 6292 ha is agricultural land, and 43.5 ha is forest. The localities of Giarmata and Cerneteaz are part of this administrative territory. Giarmata commune is located on the southeastern end of the Vinga plain, with a general northeast to southwest orientation. The Vinga Plain has average altitudes between 100

and 150 m, very wide interfluves, sprinkled with depression areas, a weak fragmentation and less relief energy (MUNTEANU I., FLOREA N., 2009).

According to geotechnical studies in the area, the soil stratifications are as follows:

- topsoil (0.2 - 0.8 m), local in the perimeter of the town of 2.1 m;
- loamy soils that include clays, dusty clays, clayey dusts, eddy-hard, wet and very wet pastes.

An important characteristic is the contraction of the clay soil, specific in areas of high amplitude, depending on the degree of humidity, recommending that the minimum foundation depth be at least 2 m, and the allowed pressure of 2 - 2.5 Kgf/cmp.

In terms of climate, the studied territory is characterized by a moderate temperate continental climate, with shorter and milder winters, frequently being under the influence of cyclones and air masses from the Mediterranean Sea and the Adriatic Sea. Its general features are marked by the diversity and irregularity of atmospheric processes. Frequently, even in winter, moist air masses appear, bringing insignificant rains and snows, rarely cold waves.

The entire area falls within a multi-year average of 10.2ºC.

The multiannual average temperature values, in the 5-10 cm layer, are higher by 2-4ºC, compared to those in the air.

The main characteristic of the thermal regime in the studied area is due to the dominant influence of the circulation of western air masses, as can be seen from the data presented in the table and figure 1.

Table 1.

Average monthly and annual temperatures,
recorded at the Timişoara Meteorological Station during 2021-2022
Average monthly temperature (ºC)

The year	Months												Average (Amount)
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2021	-0.1	-2.0	6.7	10.9	15.7	20.1	23.6	20.5	18.3	13.1	5.7	2.6	135.1
2022	-0.9	2.9	7.2	10.8	16.9	19.7	21.1	21.2	20.2	11.3	2.8	1.6	129
Multiannual average	-0.5	-2.45	6.95	10.85	16.3	19.9	22.35	20.85	19.25	12.2	4.25	2.1	132.05

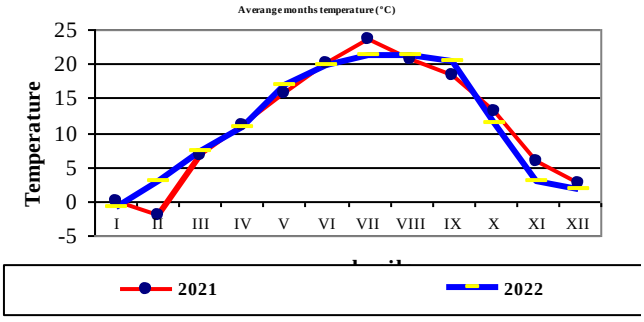

Figure 1. Average monthly temperatures at Timişoara Meteorological Station
in the period 2021-2022
- average monthly temperature (ºC)

The lowest average temperature was recorded in February, 2021, namely -2.0°C. The absolute minimum temperature during the same period was -27.2°C on 16 February 2021. The

average winter maximum temperature was 17°C and the summer minimum minimum temperature was 9°C.

The date of the first frost was on October 23, 2021. The date of the last frost was on May 12, 2021. The sum of the temperature degrees during the researched period was: 129ºC in 2022 and 135.1ºC in 2021.

The multi-year average of temperatures during 2021-2022 was 132.05ºC.

The duration of sunshine during the two years of study (table and figure 2.) is presented as follows:

- the number of sunny days per year is 29;
- the average annual insolation fraction is 0.4;
- maximum monthly insolation fraction, July = 0.80;
- minimum monthly insolation fraction, January=0.12;
- the insolation fraction during the vegetation period (1.III – 31.X)=0.52.

The sum of the multi-year average in the period 2021 - 2022 was 2195.7 hours. The number of sunny days over the year was 269. The sunniest month was July (317.0), and the least sunny was December (54.3).

Table 2.

Duration of sunshine (hours)

The year	Months												Average (Amount)
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2021	101.3	115.1	118.7	202.3	303.4	307.8	308.3	295.5	191.2	163.1	53.0	69.1	2,258
2022	68.8	79.9	205.5	177.3	167.5	288.2	327.2	311.2	255.4	156.8	103.1	66.8	2,307.9
Multiannual average	85.05	97.5	162.1	189.8	235.45	298	317.75	303.35	223.3	159.95	78.05	67.95	2,282.95

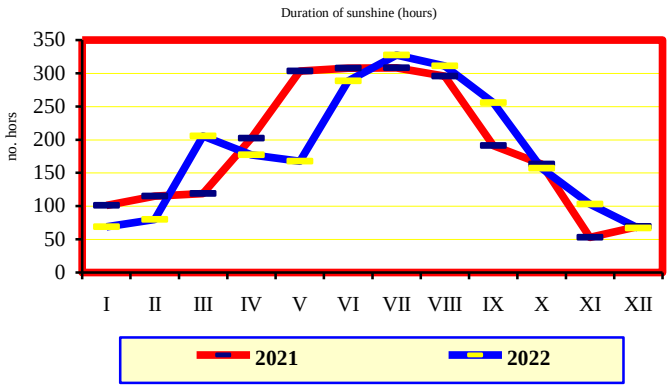

Figure 2. Sunshine duration (hours)

3. Precipitation regime

Regarding the precipitation regime, they have an annual average of 649 l/m2. However, the distribution of precipitation is uneven between the two seasons. The average annual precipitation recorded in the period 2021-2022 was 630.6 mm (table and figure 3).

Table 3.

Amount of precipitation (mm)

The year	Months												Average (Amount)
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2021	18.1	277	52.2	45.5	34.9	49.8	33.8	34.5	41.0	33.2	60.8	70.5	502
2022	57.8	38,.0	29.4	74.5	61.5	65.9	78.7	104.2	81.7	57.0	60.7	75.8	785.2
Multiannual average	37.95	32.85	40.8	60.0	48.2	57.85	56.25	69.35	61.35	45.1	60.75	73.15	643.6

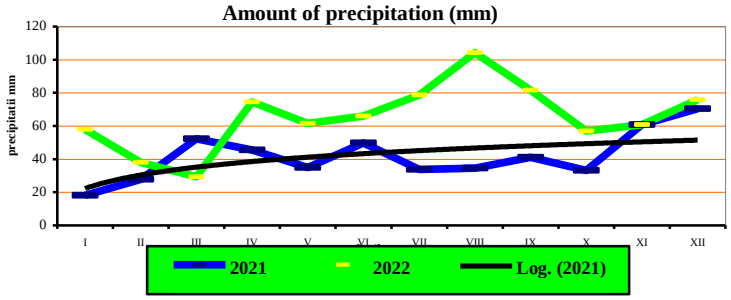

Figure 3. Monthly values of atmospheric precipitation in the period 2021-2022 (mm)

The lowest precipitation was in January 2021, respectively 18.1 mm, and the maximum monthly precipitation was in August, 81.4 mm.

The total amount of precipitation for the period 2021 - 2022 was 502.0 mm in 2021, and 785.2 mm in 2022, with a multi-year average of 643.6 mm.

Regarding the relative humidity of the air, it is evident that during the summer there is a humidity deficit, which needs to be reduced by appropriate agrotechnical measures or supplemented by irrigation (table and figure 4).

Table 4.

Relative air humidity (%)

The year	Months												Average
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2021	82	85	82	69	60	61	62	62	88	76	81	81	74.0
2022	85	80	73	66	70	74	67	69	82	80	85	87	75.7
Multiannual average	83.5	82.5	77.5	67.5	65.0	67.5	64.5	65.5	85.0	78.0	83.0	83.0	74.85

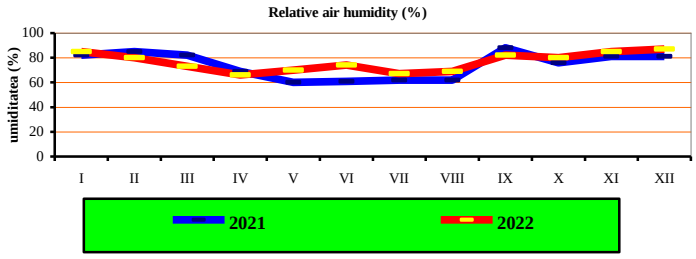

Figure 4. Relative air humidity (%)

The relative humidity is 88% in September 2021. The multiyear average relative humidity ranges from 63.7% in August to 84.7% in January, with a multiyear average of 74.2%. The average amounts of precipitation would ensure favorable conditions for most

agricultural crops if they fell uniformly over the years and had an appropriate distribution over the months.

Regarding the wind regime, the most frequent are the north-west (13%) and west (9.8%) winds, with maximum speed in the summer months. In terms of intensity, these winds sometimes reach degree 10 (Beaufort scale).

The annual average number of days with speeds greater than 11 m/s was 26.8, and with speeds greater than 16 m/s was 2.6. The calm period occupies about 20.9% of the time.

Regarding the soils of Giarmata commune and the way in which they are used. The agricultural lands that belong to the outskirts of Giarmata commune occupy a total area of 7151 ha, with the following uses (table 5):

- Arable land, 4859 ha, respectively 77.2%;
- Land occupied with pastures, approx. 834 ha, i.e. around 13.3% of the surface;
- The hayfields occupying 121 ha, which represents 1.9% of the territory;
- The orchards that are found on 305 ha and occupy 4.8% of the commune's surface.

Table 5.

The structure of the agricultural area

Total area (ha)	**Total agricultural area (ha)**	**Of which: %**				
		Arable	**Pasture**	**Grasslands**	**Vii**	**Orchards**
7151	6531	91.51	0.82	2.26	0.91	4.47

From the total area of the commune, studies and researches were carried out on an area of 157 ha, which was divided according to the predominant crops, i.e. wheat, barley, corn and sunflower (table 6).

Table 6

The area studied and the main cultivated plants

Occupied area (in ha)	Wheat	Barley	Maize	Sunflower
25	2	2	17	4
39	15	0	21	3
28	6	3	14	5
43	18	2	22	1
22 ha	3	1	10	8
TOTAL = 158	**45**	**8**	**84**	**21**

Regarding the classification of these agricultural lands in quality classes, the situation is as follows:

- Class I includes 128 ha, representing only 2.6% of the total area;
- Class II has 913 ha, representing 18.8% of the surface;
- Class III is the largest, with 2852 ha, representing 58.7% of the total;
- Class IV includes an area of 850 ha, representing 17.5% of the total of the commune;
- Class V includes the least fertile soils, with a total of 116 ha, i.e. 2.4% of the territory.

This classification into quality classes is the result of factors that limit the quality of land and which, in the current context of climate change, lead to a decrease in their productivity. These factors include:

 The moisture deficit: it acts directly on the soil, the plants and the productions obtained. During the studied period (2020-2022), the amount of precipitation was low and unevenly distributed, and the high temperatures during the summer accentuated the water deficit in the soil. This affected more than 80.1% of the town's land, except for the irrigated and those near the stream. Limitations caused by water scarcity were severe for about 7.9% of the area, moderate for 43.1% and less for 30.1%.

 Fine texture: this shows moderate limitations on Vertosols and vertic and argic subtypes of chernozems, and reduced limitations are present on about 66.9% of the surface, where Gleiosols and Stagnosols are found.

 Soil compactness: this aspect is present in soils with a higher clay content, such as Vertosols, Stagnosols and Gleiosols. Compactness appears moderately on 5.5% of these soils and reduced on 88.3% of the investigated surface. This is also accentuated by the lack of water in the soil, and climate change worsens the situation of the soils in the area.

 Land bearing: it manifests itself in a smaller proportion, affecting 19.5% of the studied area.

 Land slope: this factor presents severe, moderate and reduced limitations on certain surfaces, influencing the productions obtained. On land with steeper slopes, climate change has a stronger impact because precipitation runs off quickly and is not used by plants. Thus, the yields obtained on sloping land are lower. Terrain slope limitations affect 0.3% severe, 3.3% moderate, and 15.9% mild.

 Surface erosion: this factor limits the agricultural land in combination with the slope of the land and the fine texture, having different degrees of manifestation. Surface erosion is manifested in a very severe way on 0.7% of the studied lands, severe on about 2.9%, moderate on about 2.9% and reduced on about 9.7% of the surveyed surface.

 Deep erosion: this factor has a lower degree of manifestation, affecting only 3.6% of the studied surface.

 Terrain unevenness: manifests itself in different forms, with severe limitations on 4.6%, moderate on 12.0% and reduced on 58.3% of the surface.

 Excess phreatic moisture: this aspect occurs moderately on 7.2% of the studied area, especially on Gleiosols.

 Excess stagnant moisture: this has a lower degree of manifestation, because Stagnosols occupy limited areas in Giarmata commune and in the studied perimeter. Limitations related to excess stagnant moisture are severe at 1.5%, moderate at 0.6%, and reduced at 0.9%.

 Humidity on the slope: this has a great influence on the soil and affects 33.6% of the studied area. Intensity ranges from moderate at 20.5% to low at 13.1%.

 Overflow flooding: it manifests itself in a very serious way on 1.4% and seriously on 6.6% of the lands studied.

The predominant soils are vertical chernozems, which have a high content of clay in the first layer (Am, 42.4%) and where DA has values of 2.68 g/cm3. Their degree of subsidence is high, having a value of 9.3%. The useful water capacity is 13%.

CONCLUSIONS

The studied commune is located in the central-northern area of Timiş county, at a distance of only 11 km from the Municipality of Timişoara and 1.3 km from the "Traian Vuia" International Airport in Timişoara.

This locality covers an area of approx. 7,150 ha, of which 6,292 ha is agricultural land, and 43.5 ha forest. The studies were carried out on the surface of 158 ha, divided into 5 plots, with surfaces between 22 and 43 ha.

The main crops were corn (83 ha), wheat (44 ha), sunflower (20 ha) and barley (8 ha).

From a geomorphological point of view, the area of the commune falls within the Banato-Crişană Plain, part of the Western Plain of Romania, the eastern extremity of the Tisa Plain.

To characterize the climate conditions, the climatic data recorded and interpreted by the discipline of Agrometeorology and Climatology, within the Faculty of Agriculture, were used.

The climate is moderately temperate-continental with warm summers and mild winters due to both the influences of oceanic (from the west) and Mediterranean (from the S and SW) air masses.

The thermal characteristics of the hot season highlight the early onset and persistence of the western anticyclone, which makes the summer season start from May and continue until September. Periods of unstable weather are caused by the intermittent superimposition of colder northwesterly air masses over warm subtropical air masses. Multiannual average summer temperatures frequently exceed 20ºC.

The date of the first frost recorded during this period was on October 23, 2021. The date of the last frost was on May 12, 2021.

The sum of the temperature degrees during the researched period was: 12.9ºC in the year 2022 and 12.4ºC in the year 2021, something that shows a slight warming, a fact that is also reflected on the soils and crop plants.

The multi-year average of temperatures during 2021-2022 was 132.05ºC.

Regarding the amount of precipitation, the annual average was 649 l/m2, but it was unevenly distributed.

The predominant air movement is from west to east. Winds blow from the north at a rate of 15.7%, from the east around 15.6%, and from the south with a frequency of 20.6%.

The wind intensity is low, and the monthly average, according to the Beaufort scale, is 2.5 m/second.

The annual average number of days with speeds greater than 11 m/s was 26.8, and with speeds greater than 16 m/s was 2.6. The calm period occupies about 20.9% of the time.

As for the soil cover, it is represented by preluvosols, alluviosols, chernozims, vertosols, pelosols, gleiosols and stagnosols, representative as the surface being preluvosols and gleic vertosols.

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