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THE IMPACT OF CLIMATE CHANGES ON AGRICULTURAL LANDS IN THE SÂNNICOLAU MARE AREA, ROMANIA

Casiana MIHUT, Anisoara DUMA COPCEA, Adalbert OKROS, Vlad MIRCOV

University of Life Sciences "King Mihai I" from Timișoara, 300645, 119 Calea Aradului, Romania, Phone: +40256277001, Fax:+40256200296, E-mails: casiana_mihut@usvt.ro, anisoaradumacopcea@usvt.ro, adalbertokros@usvt.ro, vlad_mircov@usvt.ro, agatha_popescu@yahoo.com

Corresponding author: casiana_mihut@usvt.ro; anisoaradumacopcea@usvt.ro

Abstract

This study addresses a very topical issue, climate changes, increasingly present recently, with negative effects on our entire existence, with repercussions on agriculture and the way food is produced in general. In the last decade, climate changes have been increasingly present and adapting to these changes is essential. In this paper, two crops, barley and alfalfa are presented, and how these climate changes produced in the Sânnicolau Mare area during 2020-2022 had negative effects on the soils and, above all, on the production of barley and the number of mows in alfalfa. In the elaboration of the paper, the bibliographic study was combined with a series of laboratory analyses regarding the properties of the two types of soil identified. The idea was developed on the basis that we monitored the annual thermal and pluviometric regimes impact on crops and on soil evolution, through their distribution and through the specific adaptability of the plants to risk conditions in a short period of time. These climatic changes are obvious not only from one year or from one season to another: they appear within the same locality bringing obvious changes in terms of the amount of precipitation in a certain area of that locality.

Key words**:** *impact, climate change, agricultural land, production, Sânnicolau Mare*

INTRODUCTION

In the opinion of most authors, the alteration crust is a loose deposit – the result of physical-chemical processes that simultaneously affect the upper part of the lithosphere [20, 27, 31, 34].

According to various authors, climate is generally defined as “the multiannual regime or the totality of the successive changes in the weather, of all the atmospheric processes characteristic of a region, as a result of the interaction between climatic factors (radiation balance, influence of physical-geographical conditions and general circulation of the atmosphere), under the increasing influence of human activity, which can be described by means of the data recorded and processed, over a period of several years, within the local or zonal meteorological stations.” [2, 4, 11, 13, 15, 25, 26, 32, 33].

Climate influences both directly and indirectly the formation and evolution of soils through a complex of factors: temperature, precipitation, global radiation, cloudiness, relative humidity, evapotranspiration, etc. [10, 11].

The precipitation regime has a much more direct action on the soilification process than the thermal regime. In this sense, the influence of the pluviometric regime on the feldspar content of the sands in the current soils is edifying. The curve built by Grasu et al., 1996 based on Suttner’s 1974, cited by Vlad, D., data, shows an inverse exponential correlation between the two elements [1, 3, 18, 28, 35].

The combined action of temperature and precipitation influences the rate of formation of clay minerals in soils, so that, over time, the proportion of resulting clay minerals increases proportionally with humidity and exponentially with temperature [9, 19, 29].

According to Ianoș et. al., 1997, the different ways of combining the two climatic factors – precipitation and temperature – give a certain character to the alteration of primary minerals [6]. In regions with arid climate, alteration has a predominantly physical character, the product being a detrital material on account of which undeveloped soils appear [11].

Depending on the depth of the pedophreatic level, Ianoş et al., 1992 distinguishes three types of soils (the classification is also mentioned when treating the relief, both factors determining it): automorphic soils – not influenced by the pedophreatic water, with an aquifer level below 5 m; semi-automorphic soils – weakly or moderately influenced by pedophreatic water; the aquifer located at moderate depths (3-5 m), feeds, by capillary ascent, the intermediate horizons of the soil; and hydromorphic soils (gleysoils) or semi hydromorphic soils (meso- and bathy-gleyc varieties), intensely influenced by pedophreatic water, in which the aquifer located at a shallow depth moistens the soil until to the surface, by capillary ascent, at least periodically [6, 7, 8, 23, 32].

In the presence of excess water, soilification acquires certain particularities, as stated by Mihuț et al., 2018: due to poor aeration, reduction processes predominantly take place, forming reduced soluble compounds of iron and manganese, which have specific colours that they also imprint on the soil [12].

In recent times, man has become an active factor in pedogenesis, either directly – through ameliorative works or plant cultivation, or indirectly – through damming, drainage, irrigation, or erosion control works [20, 21, 22, 26, 35].

As a result of anthropogenic interventions, most of the soils have evolved, in the last hundreds of years, in intensively anthropogenically modified conditions [12, 20, 35].

In these cases, the evolution proceeded rapidly, overstepping the stages, without normal interactions between various factors involved in the process – an evolution called meta-soil-genesis [5, 17, 24].

In this context, the paper aimed to assess the impact of climate changes on the soils, barley production and the number of mows in alfalfa in the Sânnicolau Mare area during 2020-2022

MATERIALS AND METHODS

Regarding the studied area

The research was carried out in the town of Sânnicolau Mare, the westernmost city of Romania and of Timiş County, being the third largest city after Timișoara and Lugoj. Sânnnicolau Mare is a border town, 6 km from the border with Hungary, on the unregulated course of the Mureș River [14, 16, 19].

The city is in the low Aranca Plain, on the banks of the Aranca Canal, an old course of the Mureş River (in distant times, it was navigable), which gives it aspects and phenomena like large cities located on rivers and streams, but at a more reduced scale. Its location gives it a rich natural potential, being 5 km from the Mures River flooding meadow, at an altitude of 80-90 m above the Adriatic Sea (Map 1).

Map 1. Map of Romania with the city of Sânnicolau Mare in Timiș County
Source: https://ro.wikipedia.org/wiki/List%C4%83_de_comune_din_jude%C8%9Bul_Timi%C8%99 [36].

The studied area is under the influence of the Azores pressure centre and under a weak influence of the Siberian maximum barometer centre, being an area with a transitional climate between continental and ocean climate, with an average annual temperature of 10.7°C.

The climate of the area is generally under the combined influence of continental and Mediterranean climates, with more pronounced effects of the Mediterranean type: this phenomenon had, generally, beneficial effects on the development of the plants and of the area [13, 14, 32]. In general, the amount of precipitation in the studied area is sufficient for the development of plants, especially cereals (536.3 mm), but this precipitation is unevenly distributed during the vegetation period. The wind has an average speed of 2.5-3.00 m/sec. Over time, the climatic conditions have favored the development of the locality both from an economic and demographic point of view.

The hydrology of the area is the result of the combined actions of climate, hydrographic, morphological, and geological factors.

Regarding the data obtained

A series of measurements of the physical and chemical properties of the two identified soil types (chernozem and eutricambosoil) were made; research and observations were carried out on an area of 32.00 ha, on two crops – barley, on 25.60 ha, and alfalfa, on 7.40 ha.

The following properties were determined: soil texture, by the Cernikova method; soil density (cm3), with a pycnometer, using distilled water; apparent density of the soil (cm3) in natural settlement, with the help of cylinders; humus content (%), by the Tiurin method; soil reaction, by the potentiometric method, in aqueous extract 1:2.5.

Following the study of the specialized bibliography, the data provided by the Sânnicolau Mare City Hall, O.S.P.A. Timișoara, and the Sânnicolau Mare Meteorological Station and those obtained as a result of our own studies and observations from the field, this paper presents a series of data regarding the total area of the town, data regarding the climate conditions in the analysed period, together with a series of data and information related to the types of soil, the alfalfa crop, the barley crop, the requirements of the two crops in relation to the climate conditions, and the productions obtained in the period 2020-2022 [10, 18].

RESULTS AND DISCUSSIONS

The town of Sânnicolau Mare has an area of about 13,902 ha (respectively 1.55% of the area of Timiș County), of which 78.44% is represented by agricultural/non-agricultural land/other forms – 10,696 ha of agricultural land and 1,186 ha of non-agricultural land.

As for the form of ownership, 97% of the agricultural land is owned by private owners and only 3% by the state (Table 1).

Table 1. Administrative area of the city of Sânnicolau Mare

Ownership	Agricultural lands		Non-agricultural lands		Total
	ha	%	ha	%	ha
ATU public ownership	300	3	100	10	400
ATU private ownership	800	7	1,064	85	1,864
Private ownership	11,588	90	50	5	11,638
Total	**12,688**	**100**	**1,214**	**100**	**13,902**

Source: Town Planning Office, Sânnicolau Mare Town Hall [30].

The entire agricultural area is made up of the following categories of use: arable land, 10,695 ha (84%); pastures and hayfields 1,654 ha (13%); vineyards and orchards, 366 ha (3%).

The forest fund has over 36 ha in use (ranking 8th, with 0.25% of the total administrative area of the city) being represented by forests and other lands occupied by forest vegetation.

From a geomorphological point of view, the territory is part of the large morpho structural unit called the Lower Mureș Depression, an area between the Highiş-Drocea-Zărand Mountains to the north, the Transylvanian Depression to the east, the Poiana Ruscăi Mountains to the south, and the Pannonian Depression to the west. Mureșului Meadow is one of the youngest relief formations located in the northern extremity of the area, showing reduced widths from a few tens to a few hundred meters.

The morphology of the land had an influence on the drainage and depth of the groundwater: the climate and hydrographic factors and the geological factor determined the existence of the water table and the deep aquifer layers, favouring the development of agriculture. Ground water is found at a depth of 4-6 m, which contributed to the cultivation of vegetables.

The influence and action over time of the soil genesis factors (relief, rock, climate, hydrography), as well as human intervention through important hydro-ameliorative works started more than 200 years ago, determined the existence of a highly complex and diverse soil cover. Through the application of a modern land processing technology, in the period 1960-1990, the raw material was provided for the local industry, but also for other areas of the country and even for export

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to the former socialist countries (vegetable cultivation was carried out on an area of over 800 ha).

After a period of stagnation (1990-1997), the land being appropriated, this wealth begins to regain its value through associative forms: the most eloquent example is the appearance of Italian and German investors in agriculture in the area.

Although, over time, the climate conditions have favoured the agriculture of the area, there are periods when temperatures are high in the summer without precipitation and periods when humidity exceeds the normal limits.

The hydrographic network functioned well until 1990, with all the water pumping stations in operation but, after 1990, they stopped working, which determined that the waters in the surface layer reached greater depths, leading to lower agricultural productions. A first signal of resumption of operation is given by the Italian companies that work most of the land in the area and that will put the irrigation system into operation, also helped by the Romanian state. At present, the hydrotechnical system only regulates the waters that come from rains, which have been very few in the last period. The lack of underground drinking water under the hearth of the city meant that, to provide the town with the necessary water, it had to be brought from the town of Sânpetru Mare, from 14 km away, which, however, involved high costs.

Within the city of Sânnicolau Mare, the largest hydrographic network in the country was created so that the entire agricultural area is compartmentalized and surrounded by irrigation and drainage canals with great efficiency in agricultural production.

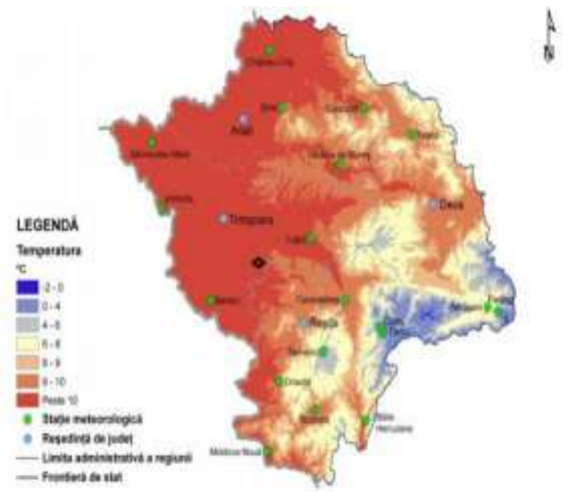
The irrational exploitation of the Mureș Meadow has left deep traces but, in the future, it might be declared a "Nature Reserve."

The biotic cover of the area, although favourable, made some economic activities difficult because of the rational non-application of environmental protection.

The final clearing of the 316 ha Zăbrani forest in 1911 by the Hungarian government caused the town to lose its most valuable biotic cover, which was thousands of years old.

According to the classification from "Geography of Romania," volume I (1983), the territory of the unit is in the temperate continental climate zone, in the climate province sector I (with ocean influences), the climate region of the middle mountains, the climate subregion of the Western Carpathians. Against the background of the zonal climate, under the influence of the local relief, characteristic topoclimates are differentiated, both vertically and horizontally, depending on the orientation of the Poiana Ruscăi Mountains and the Lipovei Hills. According to Köppen, the region falls into the boreal climate province, with cold winters, with a layer of stable snow in the winter months, with sufficient precipitation throughout the year, and a relatively moderate thermal regime.

The multiannual average temperature at the Sânnicolau Mare station registers values of 10.7°C, and the multiannual average value of precipitation is 536.3 mm (Map 2).



Map 2. Temperature map of Timiș County
(The legend: temperature; Weather station; The county seat; The administrative boundary of the region; State border)
Source: Meteorological Station in Sânnicolau Mare [10].

According to the data presented in Table 2, the average air temperature, and the amount of precipitation (monthly values) recorded at the meteorological station of Sânnicolau Mare in the interval 01.01.2020-31.12.2022 was different.

Table 2. Average air temperature (°C)

Year	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
2020	-0.5	5.1	6.9	11.9	15.5	20.7	22.7	23.9	19.5	12.6	5.8	4.8
2021	2.0	4.0	5.1	8.8	15.5	20.9	25.7	22.3	17.6	10.4	6.6	2.3
2022	0.1	4.4	4.9	9.9	18.2	23.8	24.9	24.6	16.3	13.1	7.6	4.2
Mean	1.9	4.5	5.6	10.2	16.4	21.8	24.4	23.6	17.8	12.0	6.7	3.8

Source: Meteorological Station in Sânnicolau Mare [10].

During 2020, the minimum temperature averaged 0.5°C in January, and the maximum temperature was 23.9oC in August. The year 2021 was characterized by a minimum average temperature of 2.0°C in January and a maximum of 25.7°C in July; in 2022, the minimum average temperature was 0.1°C in January and the maximum one was 24.9°C, in July.

Thus, in the three reference years, the lowest average temperature was recorded in January 2020 (0.5°C), and the highest temperature was in July 2021 (24.9°C). Regarding the amount of precipitation (Table 3), it can be observed that the most significant precipitation occurred during June-October 2020, with a maximum of 73.7 l/m^2; in 2021, precipitation was relatively high throughout the year, with a maximum of 57.9 l/m^2 in November, and in 2022, in the first half of the year, precipitation was quantitatively low, with a maximum of 23.8 l/ m^2, in May; and then, starting from the second half of the year, it reached a maximum of 65.6 l/m^2 in August.

Table 3. Amount of precipitations (l/m^2)

Year	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
2020	17.5	32.5	38.4	3.6	24.1	60.5	53.3	46.2	24.5	73.7	5.5	31.0
2021	37.1	32.1	25.7	16.9	29.6	31.4	47.2	36.9	20.3	13.3	57.9	48.2
2022	11.7	10.3	1.1	20.7	23.8	15.2	22.5	65.6	58.4	18.2	28.7	47.2
Mean	22.1	25.0	21.7	13.7	25.8	35.7	41.0	50.0	34.4	35.1	30.7	42.0

Source: Meteorological Station in Sânnicolau Mare [10].

According to the seasons, the precipitation is distributed as follows: spring 134.5 mm, summer 171.2 mm, autumn 132.8 mm, and winter 89.8 mm.

The average annual rainfall was 536.3 mm (526.2 multi-year average over a period of 30 years, 1990-2010). Precipitation recorded a maximum in June-July (135 mm) and two minimums: one, more pronounced in February, and another one, less pronounced, in September.

Periods with precipitation add up to approx. 170 days annually, with the highest frequency in June (15-17 days).

The relative air humidity is around 70% (annual average).

Torrential rains also fall in the area (showers accompanied by electrical discharges), which can have strong negative effects on soils and land.

Snow cover – winter is usually poorer in snow, the ground being covered on average 30 days/year, of which 15 days in January.

The dominant winds are those from the west and north-west, which bring precipitation in the form of showers, and those from the south-east, which are dry. In June, the north-west wind dominates, which shares 25% of the total winds; in September, the south-east winds dominate with a share of 21.5% and the south wind has the lowest frequency and blows especially in the months of April and May.

In the studied area, the average number of days with strong wind (v>11 m/s) is 35, and that of days with storms (v>16 m/s) is 7. The most dangerous months from this point of view are March-May, when the high speed of the winds associated with the high frequency of snowfalls with soft snow favours the occurrence of falls and breaks.

Solar radiation. The duration of insolation is 2,100 h/year. The annual average solar radiation is approximately 118 kcal/cm, of which 100 kcal are recorded in the hot semester and 18 kcal in the cold one.

The duration of sunshine depends on several factors such as cloudiness, latitude, seasons, and altitude.

Being in the western part of the Timiș Plain, the average annual value of the duration of sunshine at this station exceeds 2,200 h. Data analysis highlights a multi-annual average of 2,227.4 h. July has the highest monthly average, 301.8 h, and December the lowest, 61.4 h.

The locality's Meteorological Station operated between 1928-1948, resumed activity in 1953, and continues nowadays.

The studied territory presents a soil cover specific to the eastern part of the Mureș Plain, the main soil types inventoried being the grouping of land units, the meadows belonging to the City of Sânnicolau Mare, Timiș County, in the studied area where the following soil types predominate:

- Chernozems 37%;
- Cambic chernozems (glayed, vermic, salted) 6%;
- Eutricambosoils (mollic, glayed, salted) 16%;
- Gleysols and solonetz 5%;
- Vertosoils (glayed, salted) 8%;
- Alluvial soils (mollic, glayed, salty) 8%;
- Associations of soils (vertisoils, chernozems and solonetz) 20%.

As a result, the overall plant production capacity of grasslands is medium.

Soils are moderately supplied with humus and total nitrogen in the upper horizon, after which it decreases rapidly in depth. The humus reserve is medium (120-180 t/ha), higher in the mollic subtypes and lower in the cambic ones. The C:N ratio is around 15. Cation exchange capacity, degree of base saturation, and reactivity also vary with the nature of the fluvial deposit on which these soils were formed.

According to the 2021 Agricultural Census, the land situation by use category is as shown in Table 4 and Figure 3.

Table 4. Main crops and their cultivated area in Sânnicolau Mare in 2021

Crops	Cultivated area (ha)	Share of arable land (%)
Common wheat and spelt wheat	4,000	37.42
Maize	3,895	36.41
Technical plants	2,000	18.70
Vegetables, melons	100	0.93
Fodder crops	300	2.80
Potato	200	1.87
Other crops	167	1.56
Barley	25.60	0.24
Alfalfa	7.40	0.07
Total arable land	**10,695**	**100**

Source: Own calculation.

According to the data in Table 3, the crops with the highest share are common wheat and spelt wheat, with a share of 37.42% of the total arable land, followed by maize with share of 36.41%. The crops with the lowest shares are vegetables, potato, fodder crops, and other crops.

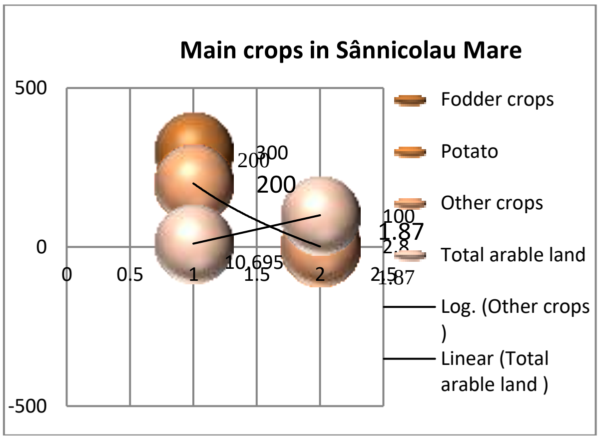


Fig. 3. Main crops in Sânnicolau Mare
Source: Own calculation.

1. Impact of climate changes on alfalfa

Alfalfa is characterized by a superior ability to adapt to different ecological conditions. The highest level of production is recorded in temperate zones, on soils that are well supplied with nutrients.

In areas where precipitation falls below 550 mm, it is recommended that alfalfa to be sown in pure culture, while in areas with precipitation above 550 mm and average annual temperatures below 10.5°C, it can be cultivated in mixture with a grass. The seeds germinate at 1°C, and the maximum temperature is 37°C. If alfalfa was sown in the spring, temperatures of -5°C can destroy the young plants. Young plants, however, if covered with snow, can withstand up to -40°C.

For alfalfa, the highest productions are obtained in areas where the average annual rainfall is between 550-600 mm and has a uniform distribution over the entire vegetation period.

As regards the requirements of the culture towards the soil, this culture has very high requirements, in the sense that it can only be cultivated on those soils that have a neutral to weak alkaline reaction (pH has values between 6.2-7.4).

The research was carried out during 2020-2021, on an area of 4.3 ha and the variety studied was Tapio. Table 5 shows both the work done on the alfalfa crop and the entire range of tractors and machines used in the preparation of the crop.

Table 5. Agricultural machines according to the agricultural work performed

Works done:	Tractor	Range of equipment
1. Ploughing after pre-emergent crop	CASE 130 CVX	Maschio Gaspardo Lelio 3+1 L
2. Soil preparation in summer		Souchu Pinet 3,2 m
3. Soil preparation before sowing		Maschio Gaspardo Grator 450 Combinator
4. Application of mineral fertilisers		Sulky DX 20+
5. Sowing		Maschio Gaspardo Nina 400
6. Mowing		Pottinger 160
7. Raking		Claas WS 280 D
8. Baling		Krone KR 125

Source: Own results.

The average air temperature recorded at the Sânnicolau Mare Meteorological Station in August 2020 was 23.9°C, and the amount of precipitation was 46.2 l/m^2, which helped the plant reach a sufficient degree of maturity to withstand low winter temperatures (the average minimum temperature was recorded in January 2021, -2.0°C).

Optimal time of harvesting was established considering the stage of development of the plants. In the present case, the first mowing took place in May 2021, when the average temperature was 29.6°C, the plant reaching the optimal stage of development being also favoured by the high amount of precipitation from the second half of the previous year.

The second mowing was carried out at the beginning of July 2021, when the average temperature was 25.7°C and the precipitation had a value of 47.2 l/m^2. The amount of green mass obtained exceeded the production of the first mowing. The third mowing was carried out at the beginning of September 2021, when the average temperature recorded was 17.6°C, and the average precipitation decreased by half compared to the previous mowing period. This led to a lower quantitative harvest compared to the previous one.

In total, for the alfalfa crop of 2021, 116 hay round big bales were obtained, each weighing about 300 kg. The total harvest was 35 t, with a slight deviation. For baling, the Krone KR 125 round baler was used.

In 2022, because of the very low rainfall in the first half of the year, the alfalfa crop had much lower yields, with the harvest reaching almost half of that of 2021. The first and second mowing yielded 30 round big bales, and the third mowing was quantitatively more productive due to the increase in precipitation in the second half of 2021, reaching 65.6 l/m^2 in August (55 hay bales).

Alfalfa production performance in 2022 compared to the year 2021 is presented in Table 6.

Table 6. Alfalfa hay production in 2022 versus 2021 in number of round big bales and tons

Year	Hay production	
	No. of big round bales	Tons
2021	116	35
2022	85	25.5
2022 - 2021 Abs. differ.	-31	-9.5
2022/2021 %	-26.8	-21.2

Source: Own results.

2. Impact of climate changes on barley

Barley technology is like wheat technology. In Romania, barley is one of the main plants used in crop rotation, being one of the frequently encountered autumn crops when it is particularly important to observe the cultivation technology.

Barley cultivation is aimed at obtaining grains, which find their usefulness in many fields. Barley has various uses, from chives and coffee substitute in human nutrition, to the manufacture of beer, glucose, alcohol, and dextrin. Barley is also one of the most important sources of animal feed, and it can be consumed in the form of grain, green fodder, straw, and hay.

For germination, the seeds need an optimal temperature of 20°C and the existence of an amount of water equivalent to 48% of the grain mass, but germination is also possible at temperatures of 3-4°C and the optimal growth temperatures are 28-30°C.

Compared with other cereals, barley has a much lower power to penetrate the soil, which is why it should not be sown too deeply. If barley is sown at depths of 6-7 cm and not 4-5, as recommended, the crop may have difficulty emerging due to the strong crust that the soil can form.

Barley twinning is more efficient compared to other cereals (wheat, rye), especially if it was sown in autumn, but it differs according to the type of barley, namely it is recommended that twinning in two-row-barley to be weaker so that the uniformity of the plants and that of the grains is not affected, while in barley and spring two-row-barley, the vegetation period is only 90-120 days.

Compared to wheat, barley is more resistant to high temperatures and more demanding on soil conditions, since it has a root stem that has a lower absorption capacity, and the vegetation period is shorter.

Compared to rye and wheat, autumn barley is less resistant to low winter temperatures, the minimum temperature of -15°C does not affect it at the level of the twinning node, only if the plants have not gone through the vernalization process.

Also, the variety has an influence on the optimal plant development environment. Thus, common barley is grown in drier or harsher areas because it has a short vegetation period, while two-row-barley (beer barley) needs a lower amount of protein in the grains, which is why it must be grown in cooler areas, where the level of humidity is high.

The optimal time for sowing is between September 20 and October 5 for winter barley, for the plants to have enough time to take root before winter comes. If barley is sown too early, there is a risk that the plants will develop too much by the time winter arrives, in which case they may be attacked by fusarium, viruses, or powdery mildew. If, however, barley is sown too late, it will have little winter hardiness.

Sowing in spring barley was done as soon as it was possible to enter the field. It has been found that, if this is delayed, there is a considerable decrease in production, the grains are smaller and of poorer quality.

In the reference period, sowing took place in the second half of October, and harvesting took place in June, when the grain reached maturity. However, due to different weather conditions in the period 2020-2022, different productions were obtained.

Due to the high level of precipitation in the first half of 2020, (a maximum recorded in June of 60.5 l/m^2) and due to the high temperatures in the following two weeks (a maximum of average temperatures of 20.7°C), the barley harvest was about 5.5 t/ha.

Compared to 2020, in 2021, the harvest was 6 t/ha. This was due to the higher amount of precipitation in the first half of 2021 (maximum in June of 31.4 l/m^2), being quantitatively higher than those recorded in 2020 when, in April, the amount of precipitation was very low (only 3.6 l/m^2, which caused the stagnation of the plant's development), but also the oppressive temperatures for germination and slow growth of the plant recorded in the second half of 2020.

In 2022, the barley crop had much lower productions than in previous years, only 4 t/ha. This was possible due to the high temperatures and precipitation in the fall of 2021, a fact that determined the early development of the plant until spiking.

Dynamics of barley yield in the period 2020-2022 is shown in Table 7.

Table 7. Evolution of barley yield, 2021-2022

Year	Yield (ton/ha)
2020	5.5
2021	6
2022	4
2021/2020 %	110.9
2022/2020 %	72.7%
2022/2021%	66.6 %

Source: Own results.

The data from Table 7 reflects that the best year for barley was 2021, when the yield was by 10.8% higher than in 2020.
The worst year was 2022 when the yield was by 35.4% lower than in 2021 and by 21.3% smaller than in 2020.

CONCLUSIONS

Sânnicolau Mare has an area of 13,902 ha (1.55% of the area of Timiș County), of which 78.44% is agricultural/non-agricultural/other forms, respectively 10,696 ha agricultural land and 1,186 ha non-agricultural land.
By categories of use, the lands are classified as follows:
- Arable land: 10,695 ha;
- Family gardens: 300 ha;
- Pastures and hayfields: 1,036.02 ha;
- Used agricultural area: 12,013 ha;
- Unused agricultural area: 48 ha.

Being located in the western part of the Timiș Plain, the average annual value of the duration of sunshine at this station exceeds 2,200 h.
Data analysis highlights a multi-annual average of 2,227.4 h. In July, the highest monthly average was found, 301.8 h, and in December, the lowest one, 61.4 h.
According to the data provided by the Sânnicolau Mare Meteorological Station, for the year 2020, the minimum temperature was in January, with an average of 0.5°C and a maximum in August, of 23.9°C. The year 2021 recorded minimum average values in January (of 2.0°C) and maximum average values in July (of 25.7°C).
The year 2022 was a warmer year, the minimum average values were positive in January (0.1°C), and the maximum values were 24.9°C, in July.
During the three reference years, January 2020 recorded a minimum value of -0.5°C, and July 2021, the highest average value of 24.9°C.
In conclusion, several requirements favouring alfalfa production can be identified, among which the following are more important:
- Temperature should be 10°C for a uniform and fast germination and the minimum of -37°C;
- If there is a layer of snow, the plants can withstand temperatures of -40°C;
- Average annual precipitation should be between 550-600 mm in order to obtain a significant production;
- Alfalfa is very picky about the soil, therefore its cultivation must be done only on soils that have a neutral or weak alkaline reaction (chernozems, preluvosoils, alluviosoils, etc.).

It is also important that the crop preceding alfalfa be the one that clears the land early, that is why wheat, barley and early potatoes are especially indicated, and in the case of alfalfa sown in the spring, sunflower or corn crops are indicated.
An alfalfa culture can be economically used for 4 years.
The highest productions are obtained in the 2nd and 3rd years.
On mows, the highest production is obtained in the first one, the others representing 50-70% of the production of the first mow (more in irrigation conditions, less in drought conditions). In general, 40-60 t g.m./ha are obtained in alfalfa and under irrigation conditions 80-100 t g.m./ha.
As for barley, sowing was done at mid-October, and harvesting in June.
In 2020, barley production was 5.5 t/ha. Compared to 2020, in 2021, production was 6 t/ha and, in 2022, production was 4 t/ha.
Thus, the highest barley production was obtained in 2021 and the lowest, in 2022.

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