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STUDY ON THE ANALYSIS OF THE MAIN AGROPRODUCTIVE PROPERTIES OF THE EUTRIC PSAMOSOL IN DOLJ

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Abstract

The study analyzes the main agroproductive properties of eutric psamosols in Dolj County, identified on large areas between Craiova and Dăbuleni, in areas with dunes subject to wind deflation. They contain a very high percentage of sandy material, being very dry and permeable. These soils benefit from a deficient moisture regime, are much poorer in humus, clay and nutrients, which is why they have a very low natural fertility, being generally used as poor quality pastures. Based on the results carried out in the field and in the laboratory, it is recommended that in order to be cultivated, these soils require radical improvement works, including: irrigation, organic and mineral fertilization with large quantities of fertilizers, combating wind deflation and cultivating with plants specific to sandy areas. The application of improvement measures has increased the bonitization scores, which demonstrates that eutric psamosols can also achieve medium fertility.

Key words: *agroproductive properties, eutric psamosol, amelioration measures, bonitation grades, fertility.*

INTRODUCTION

The achievement of quantitative and qualitative productions, which ensure a decent standard of living for the population, is closely related to the in-depth study of soil as the main means of production in agriculture.

Of the diversity of soils that we encounter in our country, psamosols (sands and sandy soils) have the weakest productive capacity, are permanently subject to the process of wind deflation and have a very low capacity to retain water in the soil. The content of nutrients is very low and the natural potential is very low.

Starting with 1955, complex research was carried out to learn about the types of soils and their agro-productive potential, in the sandy area of Dolj County, starting with the sands of Tâmbureşti. Research on these lands was intensified starting with 1959 when the Central Station for Plant Culture on Sands was established in Bechet.

Pedological research on sandy lands is a necessity for establishing methods for their rational use, taking into account the fact that their properties change through agricultural use, which makes it necessary to be constantly up to date with the situation regarding the properties and productive capacity of these lands.

According to Pop (1977), the surface of sands and sandy soils on the Danube terraces is approximately 120,000 ha.

These sands come from materials brought by the Danube from the mountainous area of Oltenia and which, under the action of the wind, were carried and deposited in the northeast in the form of dunes. Near the river, the dunes have an orientation parallel to the direction of the water flow, and further inland they acquire an orientation perpendicular to the flow, due to the action of the Austrul wind, which blows from northwest to southeast.

In the Desa-Ciuperceni area we have mobile dunes that can reach heights of up to 15 m, and in the Băileşti area we have old consolidated dunes with heights between 5 and 10 m. The length of the dunes in southern Oltenia can reach up to 3-4 km, with a width of 50 m to 800 m in the interdunes.

The two sand areas of Oltenia unite in the area where the Danube and Jiu terraces connect, between the localities of Dobreşti and Sadova.

MATERIALS AND METHODS

The research method aims at the following more important objectives (Călina et al., 2023; Călina et al., 2000): knowledge of the natural conditions for the formation of psamosols in

Dolj County. This aspect required an in-depth study from the geomorphological, lithological, hydrographic, hydrological, climate and vegetation points of view of the studied area; identification and study of eutric psamosols in Dolj County. Documentation was done in the field by executing and studying soil profiles in points covering the entire studied area and documentation at the specialized institution OSPA Dolj; determination of the main physical, hydrophysical and chemical properties of eutric psamosols in Dolj County. To achieve the established objective, field research was carried out, during which several soil profiles were morphologically analyzed and samples were collected from the most representative ones, to be analyzed in the laboratory; establishing the suitability of psamosols for different crops and methods of use.

The soil profiles were deepened to approximately 200 cm. Soil samples were collected from each horizon and transported to the specialized laboratory, where mechanical, hydrological and physico-chemical analyses were performed as (Canarache, 1990, Florea et al., 1987, Călina et al., 2000):

- the color of the horizons is determined using the Munsell Soil Color Charts, for wet and dry soil samples;
- the granulometric composition was determined by treating the soil with sodium pyrophosphate solution and separating the granulometric fractions by the wet sieving method (coarse sand), the siphoning method (fine sand) and the pipetting method, using the Kubiena mechanical pipette (dust and clay);
- the texture classes were established using the texture triangle;
- the density (D, g/cm^3), was determined by the pycnometer method, using the pump to remove air from the soil samples;
- the apparent density (Da, g/cm^3) was determined by the metal cylinder method, with a volume of approximately 100 cm3 for soil samples collected in natural settings;
- total porosity (Pt %), was calculated with the relationship: Pt % = (1- Da / D) 100;
- the maximum hygroscopicity coefficient (CH %) was determined according to the Mitscherlich method, using a 12% sulfuric acid solution;
- the wilting coefficient (CO%) was determined by calculation based on the maximum hygroscopicity coefficient, using the relationship: CO % = CH % 1.5;
- the moisture equivalent (EU) was determined by centrifuging the wet soil sample at a centrifugal force of 1000 times the gravitational acceleration;
- the usable water capacity (CU %) was determined by calculation based on the moisture equivalent and the wilting coefficient, using the relationship: CU % = EU % - CO %;
- humus (%) was calculated by the Walklei-Black method, treating soil samples with concentrated sulfuric acid and potassium dichromate;
- total nitrogen (Nt %) was determined using the Kyeldhal method;
- mobile phosphorus (P mg/100 g soil) was determined by the Egner-Riehm-Domingo method, using a photocolorimeter;
- mobile potassium (K mg/100 g soil) was determined by the Egner-Riehm-Domingo method, using a flame photocolorimeter;
- soil reaction (pH value) was determined by the potentiometric method, in 1/2.5 aqueous solution;
- calcium carbonate (Ca CO3 %) was determined using a Scheibler calcimeter in percentages.

RESULTS AND DISCUSSIONS

Distribution

According to Mihalache (2006, 2008) psamosols (solified sands) occupy an area of about 370,000 ha, which represents 1.6% of the country's surface. They are found in the Oltenia Plain on the left side of the Danube and Jiu in the area of Călmăţui, Ialomiţa and Buzău and the Tecuci Plain (Hanul Conachi). Psamosols are widespread in the steppe and forest-steppe area, therefore in areas with low precipitation, with high intensity winds, usually near rivers, lakes and the sea, on low relief units (plains, meadows). Characteristic for sands is the relief of dunes and interdunes, subject to wind deflation.

Cotet (1957) considers that both the sands on the left bank of the Jiu and those located along the Danube have a common origin, the primary material being brought by waters from the

Southern Carpathians. The sandy soils here represent alluvial deposits of the old Jiu riverbeds, as well as subsequent deposits of material that were brought by the Jiu and the Danube, transported and shaped by the wind.

Tufescu (1966) attributes the origin of the sands from the central part of Oltenia to deposits of Levantine age of lacustrine origin in which the wind played the role of shaping and transporting. The fluvial origin of the sands in this area is only attributed to the southern extremity of the area, located near the Danube.

The same fluvial origin of the sands and sandy soils on the left bank of the Jiu is also considered by Chiriţă and Bălănică (1958) in this case the sandy material being brought by the Jiu from the mountainous and hilly area, deposited in the plain and then blown away by the wind and deposited in the form of dunes. The relief of this area is particularly rough presenting many elevations as a result of the transport and deposition of sand by the wind in dune and interdune formations.

According to Maxim and Gaţă (1971) the sandy soils on the Jiu terraces present some physical and chemical properties different from those on the Danube terraces. The sandy soils on the Jiu terraces have a more uniform texture, but coarser than those on the Danube terraces which are formed from much more varied material. The chemical properties are very similar, except for humus which is richer in the sands on the Danube terraces.

Agropedological characterization of eutric psamosol

The formation and evolution of sands and sandy soils in our country occurred over time under the influence of pedogenetic factors specific to each sandy area. In general, sands in Romania have a fluvial and aeolian origin.

Flowing waters eroded, transported and deposited sandy material, after which it was transported by winds at different distances from the watercourse and deposited in the form of dunes and interdunes.

The sands and sandy soils on the left bank of the Jiu River were formed under the strong influence of this river, which eroded the material from the highlands (mountains, hills) and deposited it in the lowlands (plains), after which it was blown away by winds, especially on the left bank of the watercourse.

The natural factors that influenced the formation of psamosols were: relief, climatic conditions, parent material, vegetation, hydrography, hydrology.

The alternations of diurnal and seasonal temperatures result in the fragmentation of the superficial layer into smaller fragments, which can be removed, thus exposing new portions of rocks to the effect of disaggregation and volume increase by freezing. Both the penetration of water into the cracks of the rock, as well as the considerable pressures exerted by frost, by the growth of plant roots in these cracks, contribute intensely to the crumbling of hard rocks.

The water from precipitation together with the air that comes into direct contact with the surface of the rock fragments, causes the triggering of a new process of a chemical nature, namely alteration. Through chemical alteration, the soil radically changes its composition, so that the primary minerals of the rock are transformed into new minerals, into secondary minerals. Precipitation, being an important agent of alteration, determines the dissolution, hydration and hydrolysis of minerals (Coteț, 1973)

The water from precipitation penetrates the soil, determining the entrainment and deposition of salts and colloidal substances at different depths, playing an important role in the formation of the soil profile, respectively of the horizons.

The indirect action of climate as a factor in soil formation refers to the role of vegetation in the formation and evolution of the soil. The development of vegetation is closely linked to the climate.

The climate in the southern area of Oltenia is temperate-continental with average temperatures ranging between 10.5-11.5^{0}C, higher values being recorded in the summer months (22-23^{0}C) and lower in the winter months, below 0^0 C.

The monthly temperature variation has an upward trend from January (-2.6^{0}C in Craiova and -2.9^{0}C in Bechet) to July, when it reaches a maximum (23.0^{0}C in Craiova and 23.1^{0}C in Bechet), then gradually decreases. The multiannual average air temperature is 10.9^{0}C in Craiova and 11.3^{0}C in Bechet. The temperature difference between the middle of the warmest month (July 23.0^{0}C) and the month with the lowest temperature (January - 2.6^{0}C) is 25.6^{0}C.

In terms of precipitation, the multiannual average is 545.4 mm at the Craiova meteorological station and 519.0 mm at the Bechet meteorological station. The rainiest month was June (66.4 mm) at Craiova, and the month with the least precipitation was February (33.4 mm) at Bechet, resulting in a difference of 33.0 mm.

In the case of these soils, a rather big problem is also given by winds, especially in spring when the land is not covered by vegetation, this leading to the scattering of sandy material from the dunes and the formation of real sandstorms. Analysing the frequency and average wind speed at the Craiova and Bechet meteorological stations, it is observed that the highest speed is the winds that blow from the west in winter (4.8 m/s), and the highest frequency is the winds that blow from the west in summer (30.5 m/s). At Bechet, westerly and northeasterly winds predominate, and at Craiova the intensity and frequency of the winds is higher than at the other station.

In conclusion, if the climatic elements of the researched area are analyzed, it is observed that the microclimate aspect of the plain area is preserved with a regime of high temperatures and low precipitation combined with winds that blow frequently throughout the year, especially in spring, summer and autumn, this requiring the taking of special measures in order to ensure optimal conditions for plant development.

Regarding vegetation, it is known that the biological factor represented by plant and animal organisms has a determining role in the solidification process. Higher plant organisms, plants with chlorophyll associated with lower plant organisms, bacteria and fungi without chlorophyll, together form specific biocenoses that play a much more important role in the solidification process than animal organisms. Grassy and woody vegetation influences the solidification and humification processes through the quantity, quality and method of transformation of organic residues that remain in the soil. On sandy soils, vegetation has a weaker development compared to other soils. Natural grassy vegetation is represented by various species, such as: *Digitaria sanguinalis*, *Bromus tectorum*, *Cynodon dactylon*, *Trifolium arvense*, *Agropyrum repens*, *Vicia vilosa*, *Tragus racemosus*, *Trifolium campestre* and in agricultural crops there are weeds such as: *Delphinium consolida, Convolvulus arvensis, Cirsium arvensis, Portulaca oleracea, Setaria viridis, Sorghum halepense, Lepidium draba, Chenopodium album, Tribulus terrestris, Sambucus ebulus, Xanthium strumarium, Anthemis ruthenica, Euphorbia virgata, Ranunculus arvensis, Solanum nigrum*. Natural forests appear sporadically in this sandy area and are made up of acacias (*Robinia pseudacacia*) such as those from Tâmbureşti, Mârşani, Malu Mare, Daneţi, or pedunculate oak (*Quarcus peduncullata*) and shrubs such as *Rosa canina, Crataegus monogyna, Morus alba, Pirus piraster, Ligustrun vulgare* (Șorop et al., 1990; Răduțoiu et al., 2018).

Morphological characterization of eutric psamosol

Eutric psamosols are found on large areas between Craiova and Dăbuleni, in areas with dunes subject to wind deflation. From the studies carried out, these soils are generally found on the dune crests and on the slopes and due to the fact that their composition includes a very high percentage of sandy material, these soils are very dry and permeable. These soils are very poor and are generally used as poor quality pastures, because they have a very low fertility with a low content of organic material.

For the study of this type of soil, a soil profile executed in the southern part of the Tâmbureşti locality is presented (Figure 1). The soil has an Ao-AC-C type profile.

Figure1. Soil profile on a eutric psamosol

- **Ao horizon**: 0-41 cm depth, dark brown (10 YR 4/3) when wet and grayish brown (10 YR 5/3) when dry; unstructured or mono-granular; porous; loose; frequent filiform roots; frequent sand grains with diameter over 1 mm; weak colloid films on the surface of the sand grains; gradual transition.

- **AC horizon**: 41-80 cm depth; dark yellowish brown (10 YR 4/4) when wet, yellowish brown (10 YR 5/6) when dry; sandy-loamy texture, unstructured, porous; medium compact, to loose fibrous roots; rare synclitic material; weak colloid films on the surface of the sand grains; gradual transition.

- **Horizon C**: under 80 cm depth; yellowish color (10 YR 5/6) when wet and whitish yellowish color (10 YR 7/6) when dry; sandy texture; unstructured; porous; loose; frequent large diameter quartz sand grains; rare small diameter skeletal material.

Physical-mechanical properties of eutric psamosols

Interpreting the results of laboratory analyses (Table 1) it is found that the soil has a very high coarse sand content of 73.0% in the C horizon and decreases to 70.5% in the Ao horizon.

Table 1. Physical-mechanical properties of eutric psamosol

Horizon	Depth -cm-	Granulometric composition %				Textural Class	BD	D	TP
		Coarse sand 2-0.2 mm	Fine sand 0.2-0.02 mm	Dust 0.02-0.002 Mm	Clay < 0.002 mm		g/cm³		
Ao	0-41	70.5	17.2	6.6	5.7	NL	1.46	2.62	44
AC	41-80	71.6	17.9	5.1	5.4	NL	1.49	2.63	44
C	over 80	73.0	18.2	3.6	5.2	N	1.51	2.64	43

The fine sand content varies along the profile from 17.2% in the Ao horizon to 18.2% in the C horizon. The dust content decreases from 6.6% at the surface to 3.6% in depth. The clay content also varies from the surface where 5.7% was recorded to 5.2% in the C horizon. The granulometric composition determines the soil texture in the first two horizons to be sandy-loamy, and in the last horizon sandy. The bulk density presents values ranging between 1.46 g/cm^3 at the surface and 1.51 g/cm^3 in depth. The density increases from 2.62 in the Ao horizon to 2.64 in the C horizon. This determines that the total porosity of the soil is between 44-43%.

Hydrophysical properties of eutric psamosols

The hydrophysical indices show low values that correlate very well with the clay content (Table 2).

Table 2. Hydrophysical properties of eutric psamosols

Horizon	Depth (cm)	HC (%)	WC (%)	ME (%)	SC (%)
Ao	0-41	0.7	1.7	4.1	2.4
AC	41-80	0.6	1.6	3.8	2.2
C	over 80	0,5	1.5	3.5	2.0

The hydroscopicity coefficient (HC) has values ranging between 0.7% in the Ao horizon and 0.5% in the C horizon.
The wilting coefficient (HC %) has lower values compared to mollic psamosols, ranging from 1.7% at the surface to 1.5% in depth.
The moisture equivalent (ME) also has lower values, compared to the first soil, so that its value decreases from 4.1% in the first horizon to 3.5% in depth.
The water storage capacity (SC) is low, the capacity value for useful water being between 2.4% in the Ao horizon and 2% in the C horizon.

Chemical properties of eutric psamosols

This soil is less well supplied with organic matter, the humus content being between 0.52% at the surface and 0.25% in depth (Table 3).

Table 3. The main chemical properties of eutric psamosols

Horizon	Depth (cm)	Humus (%)	Nt (%)	P_2O_5	K_2O	pH	SH	SB	T	V (%)
				me/100 g. soil		(H_2O)	me/100 g. soil			
Ao	0-41	0.52	0.044	3.5	5.4	6.1	1.1	3.9	5.0	78
AC	41-80	0.37	0.029	3.1	5.1	6.6	0.7	3.5	4.2	83
C	over 80	0.25	0.020	2.7	4.2	6.9	0.4	3.2	3.6	88

The total nitrogen content (Nt %) is also low and ranges from 0.044% in the Ao horizon to 0.020% in the C horizon.
The mobile phosphorus content P_2O_5 ranges between 3.5 and 2.7 me/100 g. soil.
The potassium content (K_2O) decreases from 5.4 me/100 g. soil. and 4.2 me/100 g. soil. The soil reaction is weakly acidic.
The pH is between 6.1 and 6.9, the sum of exchangeable bases varies across the profile from 3.9 in the first horizon to 3.2 me/100 g. soil in the C horizon.
The total cation exchange capacity has values ranging from 5.8 me/100 g. soil Ao and 3.6 me/100 g soil in the C horizon.
The base saturation degree (V %) is between 78 and 88%.
In conclusion, eutric psamosols benefit from a deficient moisture regime, are poor in humus, clay and nutrients, which is why they have a very low natural fertility.
In order to be cultivated, these soils require radical improvement works, including: irrigation, organic and mineral fertilization with large quantities of fertilizers, combating wind deflation and cultivation with plants specific to sandy areas.

Soil evaluating in natural conditions

The growth and fruiting of agricultural plants depends on the entire complex of ecological factors, which can provide conditions from minimum to optimal for plant development.
The quantitative expression of these conditions for each natural factor and for each soil property is achieved using indicators or evaluation coefficients, which can have values from 0 to 1. At the value of "1" of the evaluation coefficient, the conditions provided for a plant by the natural factor or soil property taken into account are optimal and the highest production can be obtained. At the value of "0" of the evaluation coefficient, the development conditions are minimal and the respective plant is not recommended to be cultivated on the soil and in the respective area, because the production obtained is economically inefficient.
The value of the evaluation coefficients was established for different natural factors and for different soil properties, taking into account and processing data obtained in research and production, establishing average values for each natural factor and soil property.
The agricultural plants for which the values of the evaluation coefficients have been established are: pastures; hayfields; apple; pear; plum; cherry; apricot; peach; vines, wine varieties; vines, table varieties; wheat; barley; corn; sunflower; potato; sugar beet; soybeans; peas-beans; flax; hemp; alfalfa, clover; vegetables.
Depending on the values of the evaluation coefficients obtained by each plant, the evaluation score is calculated. Under natural conditions, evaluation scores can have between 0 and 100 points.

When the evaluation score is maximum (100), the plant finds optimal development conditions in the area and on the respective soil, obtaining high and economically efficient productions. The lower the value of the score, the lower the production, the lower the income obtained, bringing a lower profit.

Depending on the values of the evaluation scores obtained by the plants, the favourability classes can be established. Fertility class I has 90-100 points and class X has a score between 1-10.

Eutric psamosols can be found on dune plateaus and their slopes. Due to the high content of sand (coarse and fine) which occupies an average of 90% and the low content of fine material (dust and clay), around 10%, these psamosols do not retain water and nutrients.

Having a deficient humidity regime, the plants find harsh conditions for development, so that most evaluation scores are below 30 points, and the favourability classes are VII, VIII and IX, i.e. weak and very weak.

The lowest evaluation scores were obtained by hemp with 13 points, clover 14 points and hay grass 17 points.

The best grades were obtained by apricot with 51 points and peach with 46 points. It is known from agricultural practice that these two plant species are well suited to the conditions provided by sandy areas. Most crops fall into the VIIIth fertility class (14 crops), and 5 crops fall into the IXth fertility class. So, the two classes include 19 crops out of the total of 24, which highlights the very low natural fertility of this soil.

Soil evaluating in ameliorative conditions

Psamosols are generally considered to have a low natural fertility potential, because they have coarse textures, do not retain water, are poor in nutrients and are subject to the process of wind deflation.

In order to successfully and economically efficiently cultivate them, they must be characterized and classified from a technological point of view, applying specific improvement works.

By "technological characterization of agricultural lands" is meant a specialized work, through which agricultural lands are defined and classified parametrically, in terms of their physical, mechanical, chemical, biological, morphometric, morphological, climatic, etc. properties, properties that imprint different behaviours of soils in the production process, requiring a complex of agricultural technologies and improvement measures to increase their productive capacity (Teaci, 1980).

The technological characterization activity is carried out based on data obtained from the assessment of agricultural lands, taking into account a whole series of characteristics and correlations between pedogenetic factors and soil properties, such as: suitability for irrigation, prevention and control of excess moisture; flood ability; prevention and control of salinization, erosion; mechanization technologies; specifics of soil works; organic and mineral fertilization; prevention and control of pollution; reaction correction, etc.

Within each technological category of improvement works, classes and subclasses of lands have been separated, which group the lands according to the intensity of the restriction or the need to perform a certain improvement intervention.

All improvement works contribute to the improvement of natural factors and soil properties, positively influencing the growth and fruiting of plants.

For each improvement work, some "potentiation" coefficients have been established by which the evaluation coefficients are multiplied.

The potentiation coefficients are included in the annex tables that can be found in the "Methodology of Elaboration of Pedological Studies", produced and published by I.C.P.A Bucharest in 1987.

With each potency coefficient granted for a certain improvement work, the evaluation coefficient obtained by the plant under normal cultivation conditions is multiplied. Through potentiation, the value of the evaluation grades increases and therefore the productive potential of the improved lands is higher.

All improvement works through potentiation can raise the evaluation score to a maximum of 100 points. The only exception to this rule is irrigation.

This work positively influences several pedogenetic factors (humidity, temperature, groundwater, texture, microclimate), therefore it can lead to an increase in the evaluation score to over 100 points. In this case, 5 more classes from XI to XV are added to the 10 fertility classes.

On eutric psamosols, following the multiplication of the evaluation coefficients by the potentiation coefficients corresponding to the improvement works performed, the evaluation scores increased by somewhat higher percentages.

The more obvious increase is explained by the fact that eutric psamosols being less productive, the effect of the treatments is more obvious.

On eutric psamosols, after improvement, the best results were obtained for apricot with 83 points; peach with 79 points and vegetables with 72 points. Weaker results were recorded for hemp with 26 points; for clover with 30 points and for hayfields with 36 points.

For all other crops, after enhancement, the scores were between 40 and 60 points, which demonstrates that after improvement even eutric psamosols can acquire medium fertility.

This conclusion is also highlighted by the usual score for the arable land use form which is 56 points, which means the 5th class of favorability, i.e. medium fertility.

CONCLUSIONS

The formation and evolution of sands and sandy soils in our country has occurred over time under the influence of pedogenetic factors specific to each sandy area. In general, sands in Romania have a fluvial and eolian origin.

Eutric psamosols are found on large areas between Craiova and Dăbuleni, in areas with dunes subject to eolian deflation. They occupy the plateaus and slopes of sand dunes, have a deficient water regime because they do not retain water and therefore present a very low natural fertility. They have an A0-AC-C type profile.

Being rich in sand (over 90%) and poor in dust and clay, they do not retain water and nutrients. They have a coarse texture, are very poor in humus and colloidal complex, which is why they have a low cation retention and exchange capacity.

In order to be cultivated, these soils require radical improvement works, including: irrigation, organic and mineral fertilization with large amounts of fertilizers, combating wind deflation and cultivating with plants specific to sandy areas.

Due to the deficient humidity regime, plants find harsh conditions for development, so most of the evaluation scores are below 30 points, and the favourability classes are VII, VIII and IX, i.e. weak and very weak. The lowest evaluation scores were obtained by hemp with 13 points, clover with 14 points and meadow grass with 17 points, and the highest ones by apricot with 51 points and peach with 46 points.

On eutric psamosols, following the multiplication of the evaluation coefficients by the potentiation coefficients corresponding to the improvement works carried out, the evaluation scores increased by somewhat higher percentages. The more obvious increase is explained by the fact that eutric psamosols are less productive, the effect of the treatments is more obvious. After improvement, the best results were obtained for apricot with 83 points; peach with 79 points and vegetables with 72 points. Weaker results were recorded for hemp with 26 points; clover with 30 points and hayfields with 36 points.

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