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MANAGEMENT OF NATURAL RESOURCES FOR PEAR TREES IN EXPERT SYSTEM-CROM

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Abstract

The paper analyses the areas cultivated with pear trees in the EU and the productions obtained in 2019. It is noted that Italy placed first in both categories, and Romania was on the 9th place, with 3.08 thousand ha and a production of 46.16 thousand tons, according to Eurostat. At the country level, Macroregion One recorded the highest number of pear trees, 994,193 of the total number of pear trees, and in terms of production, 29% was harvested in Macroregion Three. In 2019, in Romania, 100 kg of pears were sold for 116.64 Euro, a higher price compared to that of the large pear-producing states. Also, the study presents some specific research concerning the management of natural resources for pear trees, land, and orchards in Expert System-CROM which quantifies through points of creditworthiness and penalty the climatic resources, the soil and infrastructure resources, the production, and the quality of the fruits. Following the application of the Expert System-CROM, the pear lands and the orchards received 32-100 addition points and were included into three categories: without natural restrictions, with natural restrictions and excluded for the pear trees.

Key words**:** *expert system, orchards, pear, production, Romania*

INTRODUCTION

Cultivated for the first time in Persia, pear trees later reached the capital of the Roman Empire. The inhabitants consumed the fruits fresh or cooked, a fact recorded in "Roman cookery recipes" published in the 1st century AD, "De re coquiaria". As we will observe from the analysis of the data presented in the article, Italy keeps its tradition and preference for these fruits, occupying the 1st place in the EU in terms of areas occupied by pears and pear production - 28.71 thousand ha, respectively 429.29 thousand tons [3].
Pears occupy the fourth position in the top of the most consumed fruits in the European Union. What was the basis of consumer preferences? The fact that they contain a lot of water and are rich in vitamins A, B_1, B_2, B_6, C and PP, Potassium, Magnesium, Boron, Iodine, Sodium, Calcium, Phosphorus, and Iron. Pears help reduce fever, have anti-inflammatory properties and the juice lowers blood pressure [5].
The fruit is widely used in cosmetics as an additive for creams, masks, lotions and shampoos [11].
Pears are sensitive to transport and storage. Many researchers, including Garcia J.L. [4], studied the influence of fruit pulp firmness on post-harvest damage. In order to preserve their freshness and aroma for as long as possible, the pears must be stored in suitable conditions [6]. The ideal pear storage temperature varies from -1°C to +1°C.
Starting from the tradition and characteristics of these fruits, the paper analyzes the areas cultivated with pears and the productions

obtained in the EU and in the macro-regions of Romania, in order to identify the conditions that orchards have in our country and what are the factors that underlie a success in terms of pear production, using Expert System-CROM.
Unlike annual plants, plants with a low habitus, which complete their biological cycle in a year or less, trees are plants with a large habitus, with longevity and much higher biomass production. The foliar development and the permanence of these species are the main factors that determine the establishment and maintenance of a state of balance within the fruit ecosystem.
But like any ecosystem, the state of equilibrium has a labile character and any anthropogenic intervention, without a biological and ecological motivation, can upset the achieved balance, with direct consequences on the trees and the fruit production. This explains why fruiting on fruit species depends on both the conditions of that year and the conditions of previous years [2], [12].
The lability of the balance of fruit ecosystems is greatly influenced by the biological features specific to trees. If in annual plants the growth process once completed is followed by the fruiting process, in trees both processes overlap, there are moments in the vegetation period, when there is simultaneous growth of vegetative formations, fruit growth and bud differentiation, for the future harvest.
The way in which the trees go through these critical moments are determined on the one hand by the biological requirements specific to the development processes, and on the other hand by the degree of their satisfaction, in relation to the natural potential of the formed ecosystem [8], [13].

MATERIALS AND METHODS

In the first part of the paper are analyzed the following indicators: areas cultivated with pears in the EU and by Macroregions in Romania, the number of pears existing in our country and pear production obtained in the main EU producing states, as well as in Romania, by Macroregions. The selling prices of pears in several EU countries are also analyzed. These data were taken from the Eurostat and NIS websites and are valid for 2019.
In the second part of the paper, the Expert System-CROM was used to characterize the natural resources of the pear trees lands and orchards in Romania. This system was developed in accordance with original methodology by "I.C.P.A.", which quantifies the soil, climate, and land resources by addition points [1], [2], [12], [13], [14].

RESULTS AND DISCUSSIONS

Figure 1 shows the main pear growers in the EU, for 2019. It is observed that the first place was occupied by Italy, with an area of 28.71 thousand ha, followed by Spain - 20.62 thousand ha and Portugal - 12.50 thousand ha. It should be noted that Estonia, Ireland, and Malta do not grow pears, according to Eurostat, and the other EU Member States, which were not mentioned, recorded less than 100 ha cultivated with pears. In Romania, only 3.08 thousand ha were cultivated, which placed our country on the 9th place in 2019. Although it has favorable conditions for cultivating fruit trees, Romania does not capitalize on its natural potential at its true value.

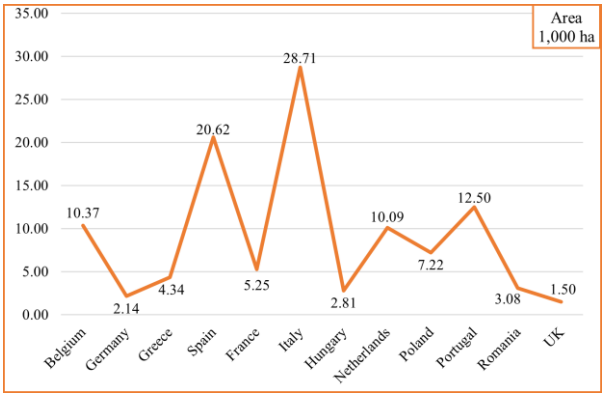

Fig. 1. Main pear growers in the EU, for 2019
Source: [3], own interpretation.

In Romania, in 2019, 3,147,062 specimens of pear trees grew. They represented 4.26% of the total fruit trees that were cultivated in our country.

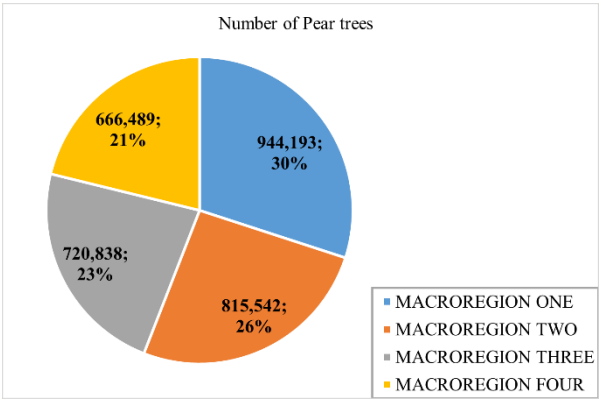

Fig. 2. Number of pear trees in Romania by macroregions, in 2019
Source: [7], own interpretation.

As it can be seen in Figure 2, Macroregion One recorded the highest number of pear trees, which accounted for 30% of all pear trees. Macroregion Four recorded the lowest percentage - 21%. In the private sector, 99.89% of the total pear trees in the country were cultivated.
Figure 3 shows the main pear producers in the EU, for 2019. Italy stands out, with 429.29 thousand tons. A production of over 300 tons was also obtained by the Netherlands, Belgium and Spain.

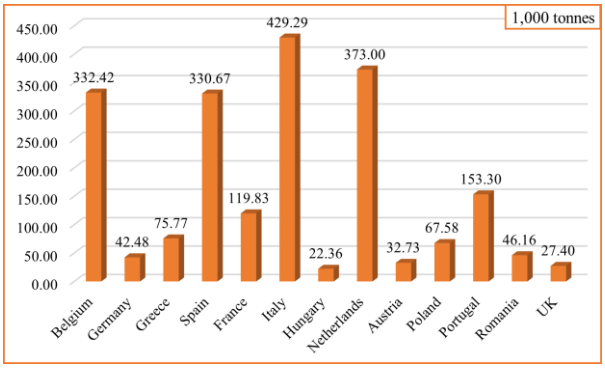

Fig. 3. Main pear producers in the EU, for 2019
Source: [3], own interpretation.

Romania appears in this ranking with 46.16 thousand tons, thus ranking 9th. In other EU member states, pear production was below 10,000 tons. It should be mentioned that the entire area and production of pears in Romania is intended for fresh consumption.
In Romania, the pear production for 2019 was distributed by macro-regions (Figure 4), as follows: Macroregion Three - 29%, Macroregions One and Two - 25% and Macroregion Four - 21%.

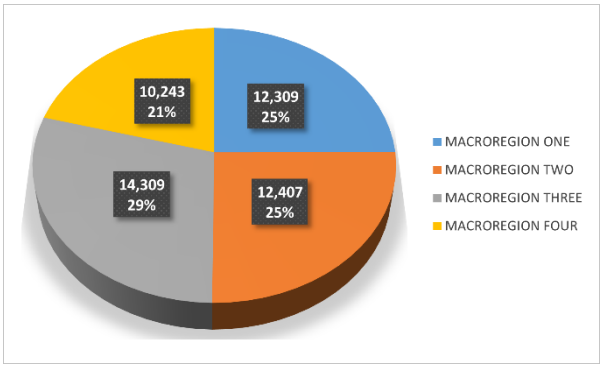

Fig. 4. Pear production in 2019 distributed by macroregions (tonnes, %)
Source: [7], own interpretation.

Of the total fruit production from 2019 pear production represented 3.31%. 99.96% of pear production came from the private sector, of which individual holdings accounted for 99.02%.
From the data presented by Eurostat, selling prices for pears (Figure 5) had the highest value in 2019 in Luxembourg - 165.00 euro/ 100 kg. At this indicator, Romania ranked 3rd in the EU with a value of 114.64 euro/100 kg.

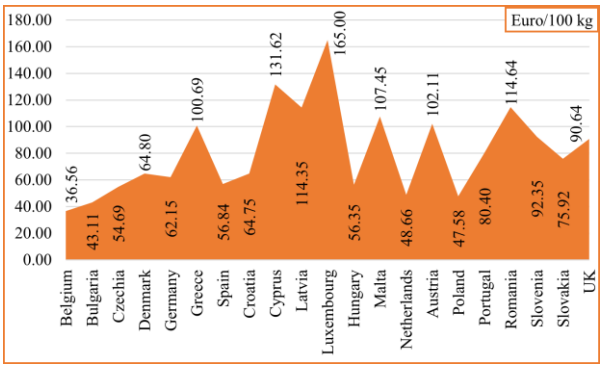

Fig. 5. Selling prices for pears in the EU, for 2019
Source: [3], own interpretation.

According to Soare *et al.* [10], pear imports were higher than exports, which led to a deficit in international trade for this category.
The use of the Expert System-CROM can allow pear tree growers to identify and know more easily the problems they may face, so that in the future we can benefit from a higher domestic production of pears and fruits in general.

In the following we will analyze using the Expert System-CROM the climate resources, the land resources and soil resources.

Climate resources expertise

The parametric assessment of the climatic resources of the lands is based mainly on the frequency of repetition of the optimal thresholds and intervals that favor the growth and fruiting of the pear trees from 10 years. Among the climatic conditions, the decisive factor is the thermal resources necessary for the normal development of the growth and fruiting processes expressed in the form of thresholds and intervals:

-The average annual air temperature receives 5-16 addition points;
-Average temperature (months V-X) receives 3-18 addition points;
-Average temperature (month V) receives 4-10 addition points;
-Absolute minimum air temperature (decreases suddenly or slowly) receives 0-4 addition points;
-Thermal amplitude of air (months XI-II receives 1-2 addition points;
-Precipitation (months V-VII) receives 8-10 addition points (Table 1).

Table 1. Climate resources expertise for pear culture

Class of expertise							Without climatic restrictions	With climatic restrictions	Excluded for pear trees
Climatic thresholds and intervals	Average air temperature (^{0}C)		Annual		08-10	Frequency, %	90-100	60-80	<60
			Addition points				*16*	*11*	*5*
			Months	V-X	≥16	Frequency, %	90-100	60-80	<60
			Addition points				*18*	*9*	*3*
			Month	V	>12	Frequency, %	90-100	60-80	<60
			Addition points				*10*	*7*	*4*
	Absolute minimum temperature (^{0}C)		Decreases abruptly		<-20	Frequency, %	90-100	60-80	<60
			Addition points				2	2	0
			Decreases slowly		<-30	Frequency, %	90-100	60-80	<60
			Addition points				*4*	*4*	*0*
	Thermal amplitude of air (^{0}C)		Months	XI-II	>20	Frequency, %	90-100	60-80	<60
			Addition points				*2*	*1*	*2*
	Rainfalls	(mm)	Months	V-VII	250-300	Frequency, %	90-100	60-80	<60
			Addition points				*8*	*8*	*10*
Addition points	*Total*						*60*	*42*	*24*

Source: [2].

Land resources expertise

For the efficient cultivation of pear trees, an analysis of land resources is based on their characterization indicators, resulting from specific research. Land characterization indicators are graded into three categories: without land restrictions, with land restrictions and lands excluded for the pear cultivation.

Land characterization indicators receive addition points, differentiated:

-The general slope receives 1-2 addition points;
-The land exposure receives 1-2 addition points;
-Surface erosion receives 0-2 addition points;
-Deep erosion receives 0-2 addition points;
-Landslides receive 0-6 addition points;
-V.S.N.P.G. receives 1 addition points;
-The aeration porosity receives 1 addition points (Table 2).

Soil resources expertise

Characterization indicators resulting from specific research, namely: active edaphic volume, soil reaction, exchangeable Al, Calcium carbonates in the soil, salinization and alkalization, industrial pollution receive differentiated addition points:

-Active edaphic volume receives 0-3 addition points;
-Soil reaction receives 1-2 addition points;
-Calcium carbonate receives 0-3 addition points;
-Soil salinization receives 1-2 addition points;
-Soil alkalization receives 0-4 addition points;
-Industrial pollution receives 0-9 addition points (Table 3).

The method of calculating the value of natural resources for pear fruit trees, land, and

orchards in the Expert System-CROM is presented in Table 4.

Table 2. Expertise of land resources for pear culture

General slope	Class of expertise			Without land restrictions		With land restrictions	Excluded for pear trees
	%			0-10		10-15	> 15
	Addition points			*2*		*2*	*1*
Aspect	Orientation			Plan E, NV, S, SE		V, SE, N-NE, in Dobrogea	N, NE, with the exception of Dobrogea
	Addition points			*1*		*2*	*2*
Relief conditions	Erosion	Surface erosion	Characterization	without erosion	weak erosion	moderate-strong erosion	very strong-excessive erosion
			Addition points	*2*		*1*	*0*
		Deep erosion	Characterization	absent	stream, drain	low density deep erosion	high density deep erosion
			Addition points	*2*		*2*	*0*
	Landslides	Characterization		absent		stabilized landslides	semi-stabilized and active landslides
		Addition points		*6*		*2*	*0*
Drainage conditions	Non-gleyed and non-pseudo gleyed soil volume (V.S.N.P.G.)	% vol.		> 60		60-20	> 20
		Addition points		*1*		*1*	*1*
	Air porosity (PA)	% vol.		5-15		15-20	> 20 | <5
		Addition points		*1*		*1*	*1*
Addition points		*Total*		*15*		*11*	*5*

Source: [2].

Table 3. Expertise of soil resources for pear culture

Class of expertise		Without soil restrictions		With soil restrictions		Excluded for pear trees
Active edaphic volume (V.E.A.)	%	≥100		101-76		<75
	Addition points	*3*		*1*		*0*
Soil reaction	pH (H_2O)	5.9-7.2	7.3-8.4	>5.8 exchangeable Al content ≥10 ppm	8.5-8.7 V_{Na}≥5%	>8.7
	Addition points	*2*		*2*		*1*
$CaCO_3$	Depth of Cca, Cpr, Rrz horizons (cm)	≥101		51-100		≤ 50
	Addition points	2		1		1
	Active $CaCO_3$ in carbonates horizon - %	3-7.0		7.1-10		>10
	Addition points	*3*		*1*		*0*
Salinization	Characterization	Non salinized	Poor salinization >100 cm	Salinization >100 cm		Salinization <100 cm
	Addition points	*2*		*2*		*1*
Alkalization	Characterization	Non alkalized		Alkalization >100 cm		Alkalization <100 cm
	Addition points	*4*		*2*		*0*
Industrial pollution	Pollutant concentration ppm	Pollutant concentration < alert values		Alert threshold		Intervention threshold
	Addition points	*9*		*5*		*0*
Addition points	*Total*	*25*		*14*		*3*

Source: [2].

Italy, the largest pear producer in the EU, currently has a pear germplasm in Sardinia, which is an important resource for genetic diversity [9]. The study of pear germplasm will allow obtaining varieties adaptable to climate change.

Table 4. Evaluation of the natural resources for pear fruit trees lands and orchards in the Expert System-CROM

Class of expertise	Natural resources			Total addition points
	Climate	Land	Soil	
Without natural restrictions	60	15	25	100
With natural restrictions	42	11	14	67
Excluded for pear trees	24	5	3	32

Source: [2].

CONCLUSIONS

In terms of marketing analysis, Italy ranks first in the top pear growers in the EU for 2019, with an area of 28.71 thousand ha, followed by Spain - 20.62 thousand ha and Portugal - 12.50 thousand ha.
In Romania, only 3.08 thousand ha were cultivated with pear trees, which placed our country on the 9th place in 2019.
3,147,062 specimens of pear trees grew in Romania, in 2019, representing 4.26% of the total fruit trees cultivated in our country.
Macroregion One recorded the highest number of pear trees - 30% of all pear trees.
99.89% of the total pear trees in the country were cultivated, in the private sector, in Romania.
Italy also stands out as the main pear producer in the EU, for 2019 with 429.29 thousand tons. Romania appears ranking 9th in this top with 46.16 thousand tons.
The entire area and production of pears in Romania is intended for fresh consumption.
In Romania, the pear production for 2019 was distributed by macroregions as follows: Macroregion Three - 29%, Macroregions One and Two - 25% and Macroregion Four - 21%.
Pear production represented 3.31% of the total fruit production of 2019 in Romania. Most production came from the private sector, more exactly the individual holdings.
Selling prices for pears had the highest value in 2019 in Luxembourg - 165.00 Euro/100 kg. At this indicator, Romania ranked 3rd in the EU with a value of 114.64 Euro/100 kg.
Following the application of the Expert System-CROM, the pear trees land and orchards received 32-100 addition points for natural resources.
Climate resources receive 24-60 addition points, land resources receive 5-15 addition points and soil resources receive 3-25 addition points.

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