Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

USE OF THE EXPERT SYSTEM-CROM IN APPLE ORCHARDS

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Abstract

Although Romania was the third apple grower in the European Union in 2018, after Poland and Italy, the country's apple production accounted for only 4.6% of total European production. The paper presents the evolution of the production of apples and the number of apples grown in the Macroregions of Romania, during the period 2010-2018, emphasizing the values registered in the Macroregion Four. Establishing the restrictions and recommendations for the improvement of the land and of the apple orchards was the main purpose of this paper. The experiments were made at Domaşnea farm, Caraş Severin County (Macroregion Four) on apple trees orchards, Golden Delicious and Starkrimson varieties.

Key words**:** *apple, criteria, expert system, indicators, orchard*

INTRODUCTION

Apple cultivation is a tradition in Romania. The total production of apples obtained in 2016, was ranked 2nd, after the plum production [9]. However, Romania continued to import large quantities of apples, especially from Poland [2].
The two varieties that were chosen for use in experiments are among the most cultivated in the country - Golden Delicious and Starkrimson [8].
In the Macroregion Four was done the research presented in this paper, where the smallest production of apples in the country was obtained for the period 2010-2018.
Domașnea Farm is located in the West Development Region (Macroregion Four), in Caraș-Severin County (Fig. 1).
Following the experiments, a set of restrictions and recommendations for apple orchards was established, through the CROM expert system.

Fig. 1. The position of the Domașnea farm in Romania
Source: [6].

The main objectives of the expert system CROM are:
- conservation of natural and artificial resources of fruit trees through the efficient and sustainable management of apple tree lands and orchards in an expert system [3], [11], [12];
- designing and testing at national level a unique and operational set of measurable

criteria and indicators, as a basis for a comprehensive (unitary) computer system, used to produce a quantified and integrated ecological model of climate resources, soil and land resources, specific infrastructure of apple tree lands and orchards [4], [5];
- establishing the value of the apple orchards and the apple tree plantations;
- efficient forecasting of the use of orchards and apples needed for evaluation in financing programs with European funds [1];
- facilitates the efforts of the Ministry of Agriculture and Rural Development for the formation of fruit farms with productions realized at low costs [7], [10].

MATERIALS AND METHODS

The expert system CROM was used to characterize the artificial and natural resources found at Domaşnea farm, in Caraş Severin. The study was conducted on apple tree orchards, where the expert system CROM was applied. This system was developed following the original methodology by "I.C.P.A.", which quantifies the land, soil, infrastructure resources and climate, the quality and the production of fruits [3], [11] and [12].
For this study were taken and processed statistics from the National Institute of Statistics [10], MARD [9] and Eurostat [7].

RESULTS AND DISCUSSIONS

From the analysis of the data made available on the Eurostat website [7] it can be concluded that Romania was the third apple grower (53,940 ha) at the European Union level, in 2018, after Poland (166,150 ha) and Italy (57,440 ha). The surface cultivated with apples in Romania represented in 2018 - 10.34% of the total area cultivated with apples of the European Union.
The apple production obtained in the same year (643,856 t) ranked Romania in the 6th place among the top apple producers, after Poland (3,999,520 t) and Italy (2,466,990 t) and represented 4.6% of the total apple production of the European Union.

Figure 2 shows the apple production obtained in the four Macroregions of the Country, in the period 2010-2018.

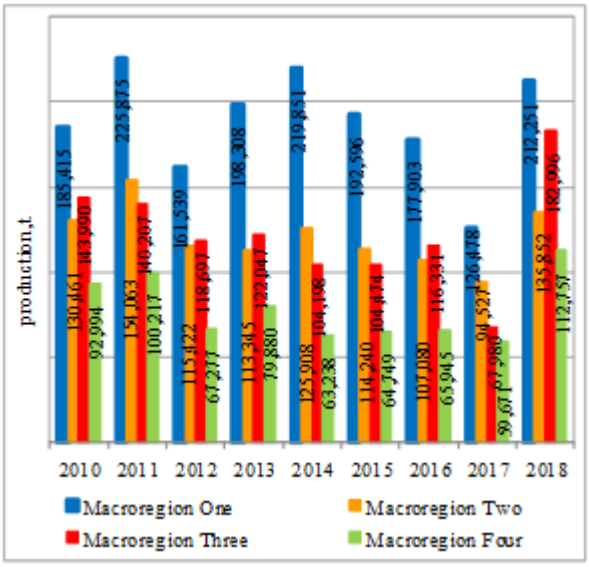

Fig. 2. Apple production in the four Macroregions of development (t)
Source: [10], own interpretation.

Analyzing the data presented in Fig. 2, we can see the increase of apple production, during the analyzed period, in all four Macroregions. Macroregion One was in the first place in terms of apple production, registering in 2018 - 212,251 t. On the last place was Macroregion Four, with 112,757 t of apples.

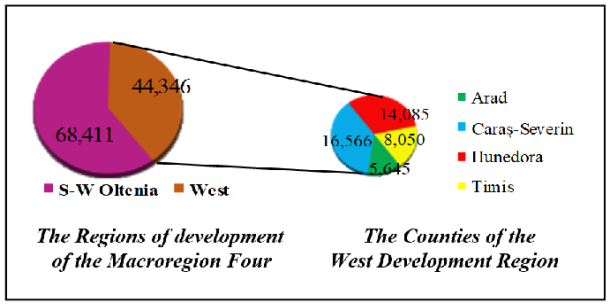

Fig. 3. Production of apples in Macroregion Four (t), in 2018, by Regions and Counties
Source: [10], own interpretation.

Within Macroregion Four, the highest apple production of 68,411 t was obtained in the S-W Oltenia Development Region (Fig. 3). In Caraş-Severin County, part of the West Development Region, the largest apple production was harvested, of 16,566 t.
Regarding the number of cultivated apples, with the exception of Macroregion Two,

during 2010-2018 the number of these fruit trees has decreased (Fig. 4).

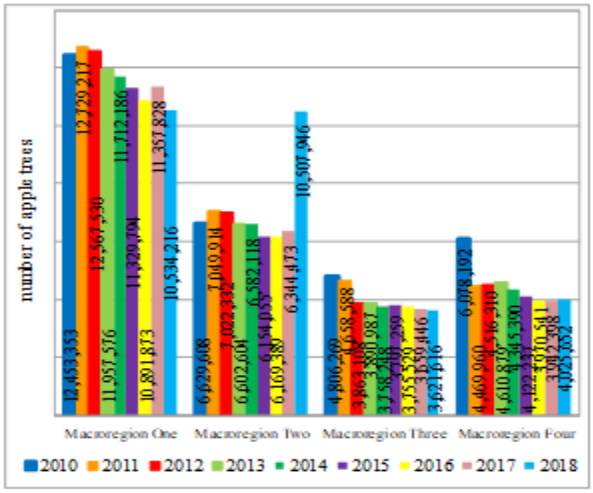

Fig. 4. The number of apple trees in the four Macroregions of development
Source: [10], own interpretation.

In 2018, Macroregion One held the first place, with 10,534,216 apple trees, and Macroregion Three last, with 3,621,616 apple trees. During the same period, in the Four Macroregion 4,025,652 apple trees were cultivated.

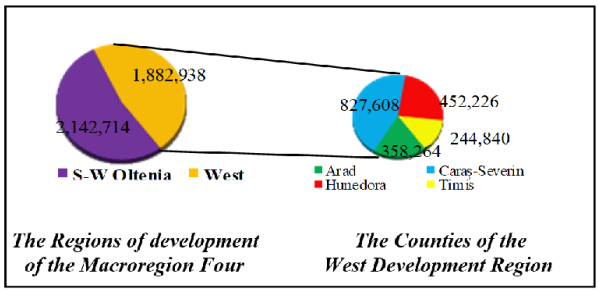

Fig. 5. Number of apple trees cultivated in Macroregion Four (t), in 2018, by Regions and Counties
Source: [10], own interpretation.

The Western Development Region held in 2018 - 46.77% of the total number of apples registered in Macroregion Four (Figure 5). In Caraș-Severin County, the most apples in the region were cultivated, 827,608 copies.
The results of the experiments performed at Domașnea Farm will be presented in the following:

Climate resources expertise
For the apple culture, the optimal average air temperature is between 7°C - 10°C and in the period of study it was 10.3°C. The frequency of repetitiveness of the optimum intervals was about 90% (Fig. 6).

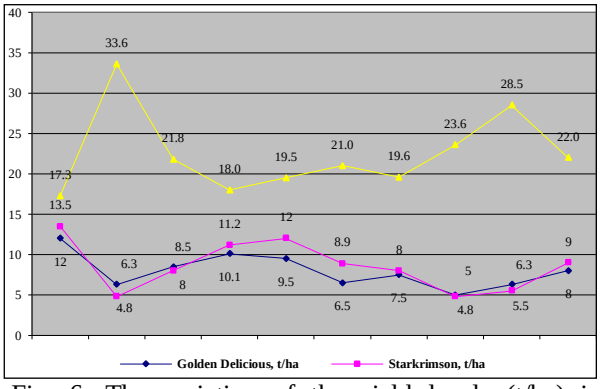

Fig. 6. The variation of the yield levels (t/ha) in relation to the thermal amplitude (°C, XI-II months) for apple trees, Golden Delicious and Starkrimson varieties, at the Domașnea farm, Caraș Severin
Source: Own determination.

For the period November-February, the thermal amplitude greater than 20°C had a frequency of repetitiveness about 40% (Fig. 7).

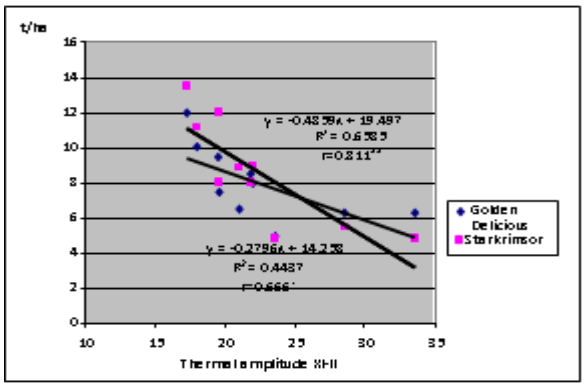

Fig. 7 The relation between the yield levels and the thermal amplitude (°C, XI-II months) for apple trees, Golden Delicious and Starkrimson varieties, at the Domașnea farm, Caraș Severin
Source: Own calculation.

After the quantification of the climatic resources for the apple trees, using the expert system-CROM, 50 addition points were obtained (Table 1).

Table 1. The quantification of the climatic resources for apple trees, Golden Delicious and Starkrimson varieties, at the Domașnea farm, Caraș Severin

Species/variety/ rootstock/age	Class of expertise	Addition points
Golden Delicious, Starkrimson/ apple/M106/25	With climate restrictions	50

Source: Own determination.

Soil resources expertise

The soil resources from the Domaşnea farm, Caraş Severin, receive 25 addition points and the apple orchards were included in the class without soil restrictions (Table 2).

Table 2. The quantification of the soil resources for apple trees, Golden Delicious and Starkrimson varieties, at the Domaşnea farm, Caraş Severin

Species/variety/ rootstock/age	Class of expertise	Addition points
Golden Delicious, Starkrimson/ apple/M106/25	Without soil restrictions	25

Source: Own determination.

Land resources expertise

For the relief conditions and for the drainage conditions 13 addition points were granted (Table 3). Also, the apple orchards from Domaşnea farm, Caraş Severin were included in the category with land restrictions.

Table 3. The quantification of the land resources for apple trees, Golden Delicious and Starkrimson varieties, at the Domaşnea farm, Caraş Severin

Species/variety/ rootstock/age	Class of expertise	Addition points
Golden Delicious, Starkrimson/ apple/M106/25	With land restrictions	13

Source: Own determination.

Expertise for apple orchards characterization criteria, production and the quality of the fruit

In Table 4 the indicators for the characterization of the apple orchards are quantified, being granted 67 addition points in the expert system-CROM.

The apple orchards infrastructure received 5 depreciation points (Table 5). The profitability of investment and the economic indicators are not affected so the production potential is in a proper balance with a proper management.

Table 4. The expertise of the apple orchards, Golden Delicious and Starkrimson varieties, at the Domaşnea farm, Caraş Severin

Species/variety/ rootstock/age	Class of expertise	Addition points	Indicators of characterization
Golden Delicious, Starkrimson/ apple/M106/25	> 20 years	10	Age of apple trees
	High	40	Assortment of species
	Good	17	Stage of vegetation for the orchards
	Total addition points	67	-

Source: Own determination.

Expertise for apple orchards infrastructure

Table 5. The expertise of the apple orchards infrastructure, Golden Delicious and Starkrimson varieties, at the Domaşnea farm, Caraş Severin

Species/variety /rootstock/age	Class of expertise	Depreciation points	Indicators of characterization
Golden Delicious, Starkrimson/ apple/M106/25	High	0	The equipping degree of the lands and orchards
	High	0	Possibilities for valorizing fruit production
	High	0	Proximity of the market
	Low	5	Possibilities of access to the market
	Total depreciation points	5	-

Source: Own determination.

The evaluation of apple land and orchard

Table 6 shows how the expert system-CROM at the Domaşnea farm was applied. The apple orchards received 150 points, being included in the category with natural and artificial restrictions.

Table 6. The evaluation of the apple trees lands and orchards, obtained by applying the expert system CROM, Golden Delicious and Starkrimson varieties, at the Domaşnea farm, Caraş Severin

Species/ variety/ rootstock/ age	**Class of expertise**	**Natural resources**			**Artificial resources**		**Total points**
		Climate	Soil	Land	Indicators of orchard characterization	Orchard Infra-structure	
Golden Delicious, Starkrimson /apple/ M106/25	**With natural and artificial restrictions**	**50**	**25**	**13**	**67**	**5**	**150**

Source: Own determination.

CONCLUSIONS

Succeeding the application of the expert system-CROM, the apple orchards at the Domaşnea farm, Caraş Severin, were included in the category with natural and artificial restrictions.

The natural conditions favor the culture of this species and the frequency of optimum temperatures is 90%, not affecting the fruit trees.

The climate factor with negative effect on the apple yields is the thermal amplitude (November-February) greater than 20°C. The recommendations are to use a larger assortment of varieties in order to compensate

the decrease of apple yields caused by the climate resources.

Domaşnea area is a specific area of fruit tree culture, Golden Delicious and Starkrimson varieties producing at their genetic capacity only in years without climate restrictions.

The range of the area for the apple species has been improved by the autumn variety cultivation, which requires a lower level of the thermal factor for the development of physiological processes.

In order to have a positive economic balance, it is necessary to respect all phytosanitary treatments.

The market is provided by the local area and the neighboring one from the counties of Oltenia.

ACKNOWLEDGEMENTS

The research was carried out with the support of the Ministry of Education, AMCSIT-Politehnica Bucharest, project 3707 CEEX.

REFERENCES

[1]AFIR (Agency for Rural Investment Financing), www.afir.info, Accessed on 19.12.2019.

[2]Cimpoi, T., Contradictory statistics. Why we import so many apples from Poland (Statistici contradictorii. De ce importam atatea mere din Polonia), https://romanialibera.ro/economie/ statistici-contradictorii-de-ce-importam-atatea-mere-din-polonia-712783, Accessed on 19.12.2019.

[3]Dana, D., Lazăr, C., Răducu, D., Ştefănescu, S.L., Voiculescu, N., 2008, Operational handbook for evaluation of the fruit trees lands and orchards using expert system, Estfalia Publishing House, Bucharest, Romania, 3-89.

[4]Dana, D., Chiurciu, I.A., Voicu, V., Soare, E. 2018, The Management of the plots and of the plum orchards using an Expert System-Crom. Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 18(1):137-142.

[5]Dana, D., Chiurciu, I.A., Voicu, V., Soare, E. 2018, Management of Sweet Cherry Tree Lands and Orchards in Expert Systems-Crom. "GLOREP 2018 Conference, Timisoara 15-17 November 2018", Conference Proceeding, 48-50.

[6]Domașnea, https://domasnea.com/asezare, Accessed on 29.12.2019.

[7]Eurostat, https://ec.europa.eu/eurostat, Accessed on 19.12.2019.

[8]Fermierul Argeșean, The best varieties of apple trees cultivated in Romania (Cele mai bune soiuri de mere cultivate in Romania), http://fermierulargesean.ro/ cele-mai-bune-soiuri-de-mere-cultivate-in-romania, Accessed on 29.12.2019.

[9]MARD, Ministry of Agriculture and Rural Development, https://www.madr.ro, Accessed on 21.12.2019.

[10]NIS (National Institute of Statistics), www.insse.ro, Accessed on 20.12.2019.

[11]Voiculescu, N., Cepoiu, N., Leca, M., 2001, The eco-pedological bases of the nutrition of the fruit species, Muntenia Leda Publishing House, Constanța, Romania, 7-296.

[12]Voiculescu, N., Hoza, D., Spiță, V., 2006, Land references values in the absorption and migration of nutrients in fruits, Elisavaros Publishing House, Bucharest, Romania, 19-291.