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USE OF ANALYTIC HIERARCHY PROCESS ON THE CHOICE OF GRAPEVINE VARIETIES SUITABLE FOR A SUSTAINABLE VITICULTURE AND MARKET DEMANDS IN THE VITICULTURAL CENTER STEFANESTI

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Abstract

The aim of this paper was to apply the AHP method for ranking grapevine varieties, evaluating the market demands and for developing a program for setting up new vineyards in a near future. Eight grapevine varieties ('Perlette', 'Muscat d'Adda', 'Fetească albă', 'Muscat Ottonel', 'Pinot gris', 'Cabernet Sauvignon', 'Burgund', 'Merlot') and nineteen quantitative and qualitative criteria have been used in the AHP exercise. The analyses were carried out using the Expert Choice Desktop software package. Based on the results, consistent with the recognition of the grapevine growing area and in the frame of climatic change conditions, Ștefănești viticultural centre requires further assessments regarding the cultivated grapevine genotypes, having a great potential for table grapes and white wine varieties.

Key words: *AHP, pairwise comparisons, ranking, Region III, Vitis.*

INTRODUCTION

From the beginning of this Century the global agricultural market has evolved to satisfy increased demand.

The Analytic Hierarchy Process (AHP) is one of the most used multicriteria decision making method that was firstly developed by Saaty (1977, 2008). This is a method that derives ratio scales from paired comparisons. AHP allows some small inconsistency in judgment because humans are not always consistent.

Being a simple and powerful tool, AHP was used both by decision makers and researchers in large areas of activity (social, personal, education, manufacturing, engineering, industry, commerce, government, sports, banking), and for different purposes (selection, evaluation, cost-benefit analysis, allocation, planning and development, priority a ranking, decision making, forecasting, medicine and other related fields) (Vaydia and Kumar, 2006; Enescu, 2017).

Also, the technique can be used for a sustainable development of the viticulture and oenology fields. AHP was applied to determine the pesticide using preferences of grapevine growers from three districts of Manisa, Turkey between environment friendly and conventional pesticide groups (Karabat and Atis, 2015). The identification of the best adaptation measure of the Tuscan viticulture under the conditions of climatic changes was realized using the same method by which three options of adaptation are specified: selection (establishing a genetic selection program so that the cultivated varieties are more suitable for the climatic conditions), relocation (relocation of vineyards to higher elevation, to reduce the impact of temperature changes and to maintain cultivation under similar conditions to the present), and switch (switch to other southern varieties, more suitable for warmer and drier projected conditions for the region) (Trombi et al., 2011). Dlbokić et al. (2017) used a SWOT – AHP hybrid model to discuss the possibilities of defining a strategy for further developing viticulture in the Jablanica district, as a sector which can potentially drive the overall development of agriculture in this region of Serbia.

In order to choose a vineyard for the production of superior quality wine, an AHP exercise included the following processes: the choice of grapevine plantation, the criteria picking, selection and significance of the examination, rating of the opinions and final aggregated priorities (Beltrán et al., 2010). This multicriteria decision method was perfectly applicable to rank wines, with fully satisfactory consistency degrees. Even though the wines are very close in quality, it is possible to obtain a more precise ranking, despite subjectivity and complexity (Pinto et al., 2016). In China, the wine industry was evaluated at Yalu River valley, to find out the main indicators affecting its competitiveness. The study explored implications and suggestions to strengthen small wineries and to empower wine companies to form a wine cluster under the Yalu River valley strategy (Yi and Lee, 2019).

In this study, the objective is the application of a hierarchical methodology for evaluating and ranking grapevine varieties, giving a scientific contribution to the viticultural market, including both table and wine grapevine varieties, by taking into consideration the Stefanesti viticultural centre tradition and new climate conditions.

MATERIALS AND METHODS

Stefanesti-Arges National Research and Development Institute for Biotecnology in Horticulture is located in the Stefanesti vineyard, in the southern central part of the Subcarpathian Mountains (Figure 1).

Figure 1. Location of Stefanesti town, Arges County, Romania (source:https://ro.wikipedia.org/wiki/%C8%98tef%C4%83ne%C8%99ti,_Arge%C8%99)

According to the Order no. 1205/2018 for the approval of the Nomination of the viticultural areas and the classification of the localities by viticultural regions, vineyards and viticultural centers, Stefanesti vineyard is part of Hills of Vallachia and Oltenia viticultural region (Region III).

Currently, the institute has a surface with vineyards that cover 156.12 ha, predominantly in the following cities: Stefanesti 34.39 ha; Calinesti 56.98 ha; Topoloveni 14.67 ha; and Pietroasa 50.08 ha. At the same time, it has an area of 400.97 ha under conservation, which can be set up as new vineyards, occupying the platform area, the slopes, the glacis and part of the Arges meadow. From a geographical point of view, the location is situated between 44°42" and 44°55" north latitude, covering the area of the Getic Piedmont, formed on the Candesti gravels and covers the left slope of the Arges River for a distance of almost 30 km. To the south, the boundary is formed by the Arges river corridor with a 2-3 km wide meadow between Pitesti and Gaesti. To the north, it climbs to the wide, smooth hills between the valleys that fragment the piedmont platform with altitudes of over 350 m. Specific to the western part of the territory is the fragmentation of the platform of deep valleys, both in the piedmont and in glacis and higher altitudes (400 m), while the eastern part of the territory is characterized by the greater extension of the unfragmented platform, crossed by valleys and lower altitudes (325 m).

A multitude of soils can be found on the territory owned by NRDIBH Stefanesti, both in a natural state as well as with deranged profiles created through management and slope levelling works. Due to the battered relief, they are mainly distributed in soil complexes. Based on the Romanian Soil Taxonomy System (SRTS), established in 2003 by the Institute for Research in Pedology and Agro-chemistry, Bucharest, the classification is in conformity with the requests present in "World Reference Base for Soil Resources" (Tarziu et al., 2000; Sparchez et al., 2013). This classification groups soils based on their characteristic genetic process and the diagnosed horizons. As such, NRDIBH Stefanesti has the following soil classes and types: Protisol class (unevolved soils) with Regosol and Aluviosol types;

Umbrisol class with Eutricambisol type; Luvisol class with Typical Preluvisol, Typical Luvosol, White Luvosol, and Planosol types; Antrisol class (blunted and rutted) with Antrosol type. Generally speaking, with the exception of Regosol and Aluviosol, all profiles are very well developed in depth, with very well differentiated horizons per soil profile (Dakers et al., 1998; Toti et al., 2017).

The viticultural recognition and the area's popularity were given over time by high quality, dry white wines ('Fetească regală', 'Fetească albă'), aromatic wines ('Tămăioasă românească') and less by the red ones that have expanded in the eastern part of the territory in the last decades of the last century.

The studied grapevine varieties were grouped in three categories: table grapes ('Perlette', 'Muscat d'Adda'), white wine ('Fetească albă', 'Muscat Ottonel', 'Pinot gris'), and red wine ('Cabernet Sauvignon', 'Burgund', 'Merlot').

The most important grapevine varieties were established with the help of 19 criteria, with a scale of 8 levels each were used in the AHP exercise, as follows: criterion 1 - time for the crop gathering (from 1: the lowest time to 8: the longest time); criterion 2 - portfolio of secondary products (from 1: few secondary products to 8: a lot of secondary products); criterion 3 - the amount of grapes harvested by a workmen in 8 hours (from 1: the lowest to 8: the highest); criterion 4 - the price of crop collecting (from 1: the lowest price to 8: the highest price); criterion 5 – expertise for identification (from 1: most identifiable variety to 8: hardest identifiable variety); criterion 6 - expertise for collecting crop (from 1: the less expertise to 8: most expertise); criterion 7 - ustensil for collecting the crop (from 1: the least to 8: the more); criterion 8 - difficulty of collecting crop (from 1: lowest to 8: highest); criterion 9 - apportionment interval (from 1: lowest to 8: highest); criterion 10 - market demand (from 1: low to 8: high); criterion 11 - the cost of raw product (from 1: lowest to 8: highest); criterion 12 - the cost of the derived product (from 1: smallest to 8: biggest); criterion 13 - transport from the field to the deposit (from 1: simple to 8: difficult); criterion 14 - perishability (from 1: lowest to 8: highest); criterion 15 - "notoriety" of the product on the market (from 1: the smallest extent to 8: the most notorious); criterion 16 - market request (from 1: lowest to 8: highest); criterion 17 - biotic menace (from 1: the rarest menace to 8: the most menace); criterion 18 - abiotic menace (from 1: the rarest menace to 8: the most menace); criterion 19 - improvement of the harvesting procedure (from 1: unimprovement to 8: to the highest degree of improvement).

Having a high degree of generality, these criteria have been also used in other fields (Braga and Dinca, 2019). Taking into account the climatic changes influences reported in the viticulture area (Buciumeanu et al., 2018; Dinca et al., 2018b), and the need to formulate solutions (Vizitiu, 2019) and recommendations (Dinca et al., 2018a), three criteria referred closely to these new climatic conditions (1 - harvesting period, 17 - biotic threats, 18 - abiotic threats).

The results were obtained with the aid of the Expert Choice Desktop software (v. 11.5.1683).

RESULTS AND DISCUSSIONS

The AHP alternative ranking, derive from experts' judgment, is presented in Table 1.

According to the AHP results, the grapevine varieties with the highest potential for Stefanesti viticultural centre were: 'Perlette', 'Muscat d'Adda' and 'Fetească albă', while the less important ones were red wines varieties (Figure 2).

Table 1. AHP alternative ranking

Criterion	Grapevine varieties							
	Perlette	Muscat d' Adda	Feteasca alba	Muscat Ottonel	Pinot gris	Cabernet Sauvignon	Burgund	Merlot
1	1	2	4	3	5	8	7	6
2	7	5	8	6	3	1	2	4
3	1	6	7	4	8	3	5	2
4	1	7	8	6	2	4	5	3
5	2	3	8	4	7	6	1	5
6	8	6	4	5	7	3	1	2
7	3	1	5	4	2	8	7	6
8	8	5	1	7	6	4	3	2
9	1	2	8	5	3	6	7	4
10	3	4	8	2	1	5	7	6
11	6	7	4	8	5	3	2	1
12	8	5	1	6	7	3	4	2
13	8	5	7	6	4	1	2	3
14	8	5	3	6	7	2	4	1
15	1	2	7	8	6	5	4	3
16	3	2	6	7	8	1	5	4
17	6	4	5	3	8	1	7	2
18	8	6	1	2	4	5	3	7
19	5	7	6	8	1	4	3	2

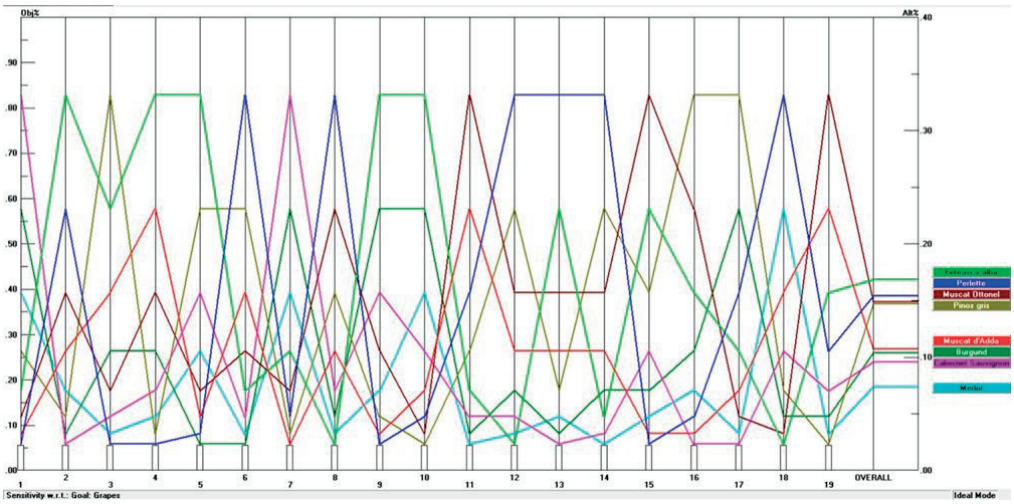

Figure 2. The ranking of the eight grapevine varieties

'Perlette' variety (seedless) is grown in the all viticultural centres with very favourable conditions for the cultivation of table varieties from the varietal conveyor. It has low frost tolerance (-18°C) and is very sensitive to downy mildew, gray mould, anthracnose, and, also, to wasp attacks. The grains crack easily, even if the overall climatic conditions are favourable during the ripening of grapes (high temperature, low rainfall) (Stroe, 2012).

Considering the consumers' demands, a special attention was paid in Stefanesti, as well as in Dragasani and Pietroasa in obtaining seedless varieties. Compared to other varieties for raisins, Perlette variety has a high production.

Perlette 10 St (clonal selection of 'Perlette' variety, obtained at NRDIBH Stefanesti-Arges/Certificate no. 1701/2008) has a good tolerance to drought and a lower frost tolerance; it has medium tolerance to the downy mildew and powdery mildew and the gray mould, due to the compactness of the grains on the bunches.

'Muscat d 'Adda', a variety for table grapes, is grown in most viticultural centres in the south and on restricted areas in the west of the country (51 centres). It has a relatively low tolerance to the action of low temperatures, but has a better drought resistance. It is a very sensitive variety to downy mildew that attacks the inflorescences just before flowering, the attack intensifying proportionally with canopy density (Stroe, 2012).

'Muscat d'Adda 22 St.' (clonal selection of 'Muscat d´Adda' variety, obtained at NRDIBH Stefanesti-Arges/Certificate no 4419/2009) has good resistance to drought and disease (downy mildew, powdery mildew, gray mould).

'Fetească albă', a white wine variety, is widespread being cultivated in many viticultural centres, 77 - after some authors, 127 - after others, spread in the Transylvania plateau, Moldavia and Muntenia. It is a good variety of sugar accumulator (200-240 g/l), with a good acidity in the northern areas, around 5.6‰, and decreasing in the southern areas (due to acid combustion) (Stroe, 2012).

Under normal conditions, 'Fetească albă' 97 St. (clonal selection of 'Fetească albă', obtained at NRDIBH Stefanesti-Arges, Certificate no 1699/2008), has a medium tolerance to frost and some cryptogamic diseases (downy mildew and gray mould).

Oenotherapy (therapy with wine) and uvotherapy (therapy with grapes) have been placed together with the balneological conditions in different specialized sanatorium, based on the treatment of gastric, cardiac, pulmonary, renal diseases and many others illnesses (Gaina, 2000; Nicolaescu et al., 2008). Wine, grapes and other grapevine derivatives (grape seeds, leaves and dried marc) are used not only in naturist medicine, but also in cosmetics.

Despite information that moderate red wine consumption has beneficial effects on health

due to its content in bioactive substances (resveratrol, hydroxytyrosol, melatonin) (Fernández-Mar et al., 2012), red wine varieties were ranked on the latest positions.
By specific methods, the breeders improved the plant resistance to diseases, pests and unfavourable environmental factors and, most often, the results have led to increasing the plant's production potential.

CONCLUSIONS

By analysing eight grapevine varieties grown in Stefanesti viticultural centre from the point of view of AHP method, which took into consideration 19 different criteria (including the request on the market, knowledge for recognition, and biotic and abiotic threats that can influence the crop) the most appreciated in this region were table grapes varieties ('Perlette', 'Musca d'Adda') and 'Fetească albă' variety for white wine.
The result is consistent with the recognition of the area for dry white wines production. Despite information that moderate red wine consumption has beneficial effects on health due to its content in bioactive substances, red wine grapevine varieties were ranked on the latest positions. Arising a great potential for table grapes, Stefanesti viticultural centre requires further assessments regarding the cultivated grapevine varieties, considering the conditions of climatic changes.

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