The Use of GIS Technologies in the Monitoring Grapevine Plantation

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**Abstract:** Precision agriculture represents a management approach for the entire agricultural area of a county, in this case, Ialomita county. Precision agriculture uses geographic information technology, positioning satellite data (GNSS), remote sensing and proximal collection of data. Precision agriculture is an agricultural management concept based on the observation, measurement and control of crops. Another term used to describe precision agriculture is the term crop management. Precision agriculture uses information technology to ensure that the soil and crops receive exactly what they need in the quantities required for health and productivity over time. Also, this ensures profitability, sustainability and protection of the environment, which is why it presents only benefits. In the near future using information technologies will play an increasingly important role in agricultural production and resource management.

1. INTRODUCTION

The concept of precision agriculture appeared in the early 80s in the United States of America. Precision agriculture uses the technology offered by geographical information systems in agriculture, maximizing the results obtained in the vineyards. Automation brings a lot of benefits, by processing data, creating topographic maps, and checking the state of the soil and plantations. Precision agriculture and the technology offered by geographic information systems have become indispensable, even more so when we talk about their impact on the monitoring of vineyard plantations in Romania.

Precision agriculture includes three basic components:
1. Acquisition of data at appropriate scale and frequency;
2. Data analysis and interpretation;
3. Implementation of management measures at the appropriate scale and time (Anisi et al., 1998).

Geographical Information Systems offer programs intended for spatial analysis and data. With the help of the software, data can be obtained on the size and quality of the crop and the factors that affect the development of plants. These factors include soil fertility, disease, pest and weed control, rainfall distribution, temperature, altitude, etc. Moreover, GIS technology ensures planning actions, necessary to eliminate the factors that can limit the use, number, or quantity of chemical preparations in agriculture, primarily, pesticides by preventing their application, when not it is necessary (Todiraş, 2003).

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Hopkins (2015) defined Geographic Information Systems software as intended to coordinate the data generated at different times. This software provides the interpretation of geographic data to create maps of the study areas.

Relationships in the database are given in coordinates on the Globe (UTM, longitude/latitude or grid X, Y coordinates). GIS technology combines digital maps, functions from the database of data, and viewing geographic information. GIS software cannot confirm the quality of the entered data and the interpretation of the obtained values. This function requires an operator familiar with the digital information used (Anisi et al., 1998).

There are two categories of data in GIS:
1. Spatial data – are those that describe geographic forms and specific positions in the database. Data spatial are represented by points, lines, or polygons.
2. Attributive data – describe spatial data. For example, the boundary of the study area shows a polygon and it may have attributes characteristic of the land, insolation, or irrigation.

Biological data can also be considered as assignment data of the study area.

The practice of precision agriculture represents great potential for the practice of agriculture. More and more farmers are turning to the latest technologies in the field (automated GPS systems and monitors, sensors, monitoring and control systems, etc.) to ease their work and achieve outstanding results with controlled distributed resources. Precision agriculture used in viticulture can be used for the entire area of Ialomiţa county, as well as in individual vineyards (Hedley, 2013; Santesteban et al., 2012).

2. MATERIAL AND METHODS

2.1. Study Area

Ialomiţa County is one of the oldest territorial administrative units of Romania. It is located in the southeast, occupying a part of the eastern subdivision of the Romanian Plain, Bărăganul. The total area of the county is 4453 km$^2$ of which: 3,736 km$^2$ is agricultural area, 258 km$^2$ area with forest vegetation, 389 km$^2$ is land for other purposes, and almost 69 km2 is unproductive land. The county is at the intersection of old trade routes that still give it the character of a transit area between the East (via Constanţa) and the West. Ialomiţa County is crossed by the lower course of the river with the same name, but also by the Danube River, between its branches Borcea and Old Danube, there is a large area with high agricultural potential.

The county seat is the municipality of Slobozia. The county borders the counties: Prahova, Buzău, Brăila (to the north), Constanța (to the east), Călărași (to the south), and Ilfov (to the west). (Figure1)

The relief of Ialomiţa County bears the imprint of its location in the eastern division of the Romanian Plain – Bărăganul, being dominated by extensive tabular fields and meadows. About 65% of the county’s surface belongs to the Bărăganu Plain, 15% to the Danube Meadow, 9% to the Vlăsia Plain and 11% to the Ialomiţa meadow and the Argeș-Buzău rambling plain. From a geological point of view, the area of Ialomiţa is a marine lacustrine sedimentation basin. Altitude-wise, the relief in the county unfolds in steps from north to south and from west to east.
The highest area - 91 m is on the Hagienilor Plateau, near the village of Platonești, joined by Piscul Crăsani - 81 m and Câmpul Grindu - 71 m. The minimum altitude is 8 m, in the north of the dammed enclosure of Borcea Arm (Mutihac, 1990).

The climate of Ialomița county is temperate-continental characterized by very hot summers and very cold winters, by a relatively large annual and diurnal thermal amplitude, and by precipitation in small amounts. The average annual duration of sunshine is between 2,100 and 2,300 hours, and the annual number of days with clear skies is 110.

![Figure 1. Map of the study area](image)

From a pedological point of view, in Ialomița county there are the following types of soils: chernozems (193,000 ha.), cambic soils (25,000 ha.), brown-reddish chernozems (1,000 ha.), alluvial soils (36,000 ha.) and saline soils - solonceacura and solonets (800 ha.). Most of the soils are favorable for agriculture, constituting one of the riches of Ialomița county. The lithology is mainly made up of loess and loessoid deposits of alluvial-colluvial and secondary aeolian origin. The soils of the area belong to the chernozeomic mollisols of the plateaus: chestnut chernozems, cambic chernozems, argiloiluvial chernozems, leached chernozems, peaty and gray soils, regosols, psammosols and anthropogenic soils. The physical and chemical properties of these types of soil recommend them as very favorable for grapevine culture (Rusu & Niță, 2004).

In broad terms, the wine-growing region is a large-scale habitat that presents the same characteristics in terms of ecological conditions, soil types, assortment of varieties and maintenance technologies applied to vines and winemaking (Virgin Wine Online, n. d.).

The study area is part of the “Danube Terraces”. The “Danube Terraces” are located in the southern part of Romania, on the left side of the Danube River, starting from Zimnicea town, which is part of Teleorman county (the most southern wine-growing center of the country) and ending with Insuraței - Brăila county, which is located in the east of the Bărăgan Plain.

The quality of the wines with the Geographical Indication “Terasele Dunării” is ensured by the geographical environment, with its natural and human factors, the natural conditions encountered here being among the most favorable for the cultivation of vines. The wine-growing region
of the “Danube Terraces” includes two vineyards, Ostrov (Constanța county) and Greaca (Giurgiu County), to which are added 4 independent wine centers: Giurgiu (Giurgiu County), Zimnicea (Teleorman County), Fetești (Ialomița County) and Insuraței (Brăila County). The Ostrov vineyard also includes the Ostrov, Băneasa, Oltina and Aliman wine centers. All these vineyards and wine centers are characterized by somewhat similar features, determined by the geological structure and production directions (Mutihac, 1990). (Figure 2)

The main form of relief on which the vine plantations are cultivated is the terrace, and the transition to the next terrace is made through a slope with southern exposure, without erosion processes. The Danube Terrace System constitutes a distinct geomorphological unit and had as its cause the accumulation of loessoid deposits and the phenomenon of continuous uplift of the Burnaz Plain. The relief of the region is therefore made up of flat terrace surfaces and slopes, including terrace fronts, towards the Danube valleys, but also includes a plain area parasitized by wind-swept sands (Insuraței). Most of the wine plantations are located on the lower step and the slopes of its Danube slope and the slopes, torrential valleys arranged in terraces. The altitude at which the plantations are located is low and does not exceed 150 m.

The wine-growing region of the “Danube Terraces” is characterized by a transitional temperate continental or excessively temperate continental climate, with a high caloric balance, large amplitudes (77.7°C) of the air temperature (with warm summers and frosty winters), quantities of relatively low rainfall, with torrential rains in the summer and periods of drought sprinkled throughout the year, but also with influences due to the proximity of the Danube river and the lakes in the area, which determine the simultaneous accumulation of sugars, anthocyanins and tannins. Some of the highest values of heliothermic resources in the country are found here. The winds influence the vegetation and the production differently, the masses of strongly continentalized air during the vegetation period positively influence the ripening of the grapes and therefore the quality of the wines obtained.

The average annual temperature is 10.9°C (-1°C in January and +22°C in July), the average temperatures during the growing season are between 10.5-22°C, the sum of the temperatures in the period of vegetation registering a multi-year value between 3451°C (Insuraței) and 3861°C (Zimnicea). The highest temperature values during the summer are recorded in the wine-growing centers of Giurgiu and Zimnicea, where the average maximum temperature in August is 29.9°C, but it can also reach values of 42.9°C this month. The conditions of microclimate and relief with microscopes cause temperatures in winter to drop relatively frequently and up to -10-18°C (absolute minimum of -34.8°C), except for the Ostrov vineyard, which benefits from longer winters mild with minimum extremes as low as -24°C.

3. SPATIAL ANALYSIS OF THE STUDY AREA

Tables 1 and 2 show the productions obtained in Ialomita county, according to the statistical data provided online by the National Institute of Statistics. The analyzed period is 2015 – 2021.

According to the data provided by the National Institute of Statistics (Table 1): the most productive year was 2017 with a production of 5862 kg/ha. The year in which the lowest production was recorded is 2021. It is also observed that there is a sharp tendency to decrease production starting in 2018.

From Table 2 we can see that the highest production was obtained in 2017 both in the private sector and the individual sector. In the case of hybrid vines, it was found that 2017 was the most productive year. The year 2021 is considered to have the lowest production regardless of the form of ownership.

### Table 1. Average production of grapes per hectare

<table>
<thead>
<tr>
<th>Vineyard</th>
<th>Year</th>
<th>UM: Kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total vineyard on fruits</td>
<td>3916</td>
<td>3778</td>
</tr>
<tr>
<td>Grafet vineyard on fruits</td>
<td>4014</td>
<td>2354</td>
</tr>
<tr>
<td>Hybrid vineyard on fruits</td>
<td>3914</td>
<td>3808</td>
</tr>
</tbody>
</table>


### Table 2. Total grapes production by property forms (tonnes per year)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Total</td>
<td>12344</td>
<td>11894</td>
<td>18414</td>
<td>12050</td>
<td>11725</td>
<td>11413</td>
<td>9859</td>
</tr>
<tr>
<td></td>
<td>Private sector</td>
<td>12344</td>
<td>11894</td>
<td>18414</td>
<td>12050</td>
<td>11725</td>
<td>11413</td>
<td>9859</td>
</tr>
<tr>
<td></td>
<td>Individual farms</td>
<td>12175</td>
<td>11832</td>
<td>18252</td>
<td>11889</td>
<td>11634</td>
<td>11320</td>
<td>9858</td>
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<tr>
<td>Vineyard on the fruits</td>
<td>Total</td>
<td>277</td>
<td>153</td>
<td>318</td>
<td>259</td>
<td>178</td>
<td>118</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Private sector</td>
<td>277</td>
<td>153</td>
<td>318</td>
<td>259</td>
<td>178</td>
<td>118</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Individual farms</td>
<td>111</td>
<td>93</td>
<td>158</td>
<td>99</td>
<td>87</td>
<td>86</td>
<td>92</td>
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<tr>
<td>Hybrid vineyard on the fruits</td>
<td>Total</td>
<td>12067</td>
<td>11741</td>
<td>18096</td>
<td>11791</td>
<td>11547</td>
<td>11295</td>
<td>9767</td>
</tr>
<tr>
<td></td>
<td>Private sector</td>
<td>12067</td>
<td>11741</td>
<td>18096</td>
<td>11791</td>
<td>11547</td>
<td>11295</td>
<td>9767</td>
</tr>
<tr>
<td></td>
<td>Individual farms</td>
<td>12064</td>
<td>11739</td>
<td>18094</td>
<td>11790</td>
<td>11547</td>
<td>11234</td>
<td>9766</td>
</tr>
<tr>
<td>Table grapes</td>
<td>Total</td>
<td>49</td>
<td>38</td>
<td>90</td>
<td>49</td>
<td>40</td>
<td>64</td>
<td>43</td>
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<tr>
<td></td>
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<td>49</td>
<td>38</td>
<td>90</td>
<td>49</td>
<td>40</td>
<td>64</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Individual farms</td>
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<td>75</td>
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<td>32</td>
<td>32</td>
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<tr>
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<td>11685</td>
<td>11349</td>
<td>9816</td>
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<tr>
<td></td>
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<td>11856</td>
<td>18324</td>
<td>12001</td>
<td>11685</td>
<td>11349</td>
<td>9816</td>
</tr>
<tr>
<td></td>
<td>Individual farms</td>
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<td>11794</td>
<td>18177</td>
<td>11855</td>
<td>11602</td>
<td>11288</td>
<td>9815</td>
</tr>
</tbody>
</table>

4. CONCLUSION

Precision agriculture is starting to gain more and more ground, becoming a branch of traditional agriculture. Precision agriculture has technologies offered by geographic information systems, it also uses different types of sensors that can provide data in real-time, use of agricultural surfaces through satellites, remote sensing, drones, GIS software, soil mapping, etc.

Precision agriculture is correlated with agricultural land resource management, and land use planning, including assessment and interpretation of soil information, land use, integrated with agroclimatic resources, needs crops and other environmental factors, which influence the production potential, to determine limits and potential of agricultural production (Todiraș, 2003).

Varieties of grapes for wine grown in the wine-growing region of The Danube Terraces: Crâmpoșie, Feteasca Regală, Feteasca Albă, Riesling Italian, Riesling de Rhin, Pinot Gris, Pinot Blanc, Sauvignon, Chardonnay, Băbască Gri, Aligoté, Traminer Roz, Romanian Incense, Muscat Ottonel, Cabernet Sauvignon, Cabernet Franc, Merlot, Malbec, Negru de Drăgașani, Pinot Noir, Black Girl, Black Girl, Sangiovese, Syrah, Dornfelder, Rebo.

References


