Integrative approach for sustainable viticulture in Portugal's Douro Valley: The NOVATERRA approach in mountain viticulture

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Abstract. United Nations' Sustainable Development Goal number 12 pledges to ensure the sustainability of production and consumption of the food system. Towards more sustainable agriculture, a reduction of contentious pesticides, increasing spray application efficiency, and supporting strategies for integrated control is required. This can be obtained by developing innovative eco-friendly strategies that protect both the environment and human health. In this sense, SOGRAPE, a family-owned wine company, is a partner of project NOVATERRA (funded by EU's Horizon 2020), aiming at improving the sustainability of viticulture by integrating new plant protection products (PPPs) of natural origin, biodiversity conservation, precision agriculture, robotics, and integrated soil and crop management strategies. NOVATERRA project trials have been made at SOGRAPE's Quinta do Seixo, located in Cima Corgo, central sub-region of the Douro valley. This project is based in a practical and integrative approach, promoting multivariate case studies, in real scale trials executed by SOGRAPE to maximize adoption of successful solutions obtained from case studies. In this way, SOGRAPE engages in promoting the sustainability of the viticulture sector, working on several assignments of the project. The novel approaches assessed in NOVATERRA project work for the same goal of paving the way towards increasingly sustainable agriculture, combined into an integrated vine protection strategy.

1 Introduction

United Nations' Sustainable Development Goal number 12 aims to ensure the sustainability of the food production and consumption system, reducing impacts of plant protection. The sector of agriculture has been evolving over the years in response to world population growth requiring a need to increase agriculture productivity while ensuring food security and healthy food access [1,2]. The introduction of new technologies for supporting vineyard management has allowed maximizing the quality of production, while, at the same time, ensuring the preservation of the environment and overall sustainability [3,4]. In this way, the concept of precision agriculture/viticulture consists in the application of new and emerging information technologies to optimize vineyard performance, improve grape yield and quality, while minimizing the environmental footprint of production [3,5].

As a wine company with a long track record of social responsibility and focused in protecting people and the planet, SOGRAPE operates and invests smartly, implementing initiatives that have positive impacts on nature and biodiversity. In this sense, it has joined an international project, NOVATERRA, with trials being executed at its Quinta do Seixo, property located in the Cima Corgo central sub-region of Douro valley.

2 NOVATERRA: The Concept

The NOVATERRA (funded by EU's Horizon 2020 - 101000554) project's overall goal is to ensure food safety and access to a healthy diet for a growing population. Fertilizers and plant protection products (PPP) application is an important process in agriculture. Nevertheless, this cultural practice has changed in recent years due to the European Directive for Sustainable Use of Pesticides (2009/128/EC) [6-8]. The new guidelines consist of rational use of chemicals in agriculture, increasing spray application efficiency, and supporting strategies for integrated control [8]. The project´s purpose is to create a more comprehensive approach to the future of the agriculture business, based on case studies with multivariate analysis of the use of biopesticides, optimized smart agriculture techniques, robotics, new soil

management strategies and a functional biodiversity assessment (Fig. 1).

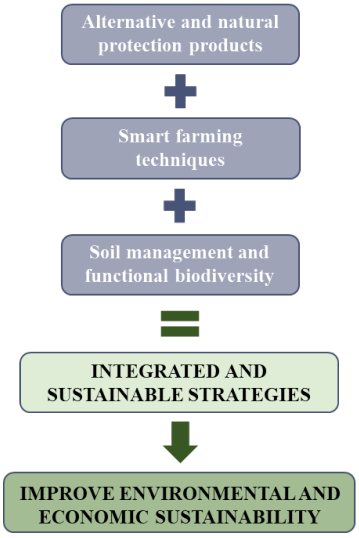

Figure 1. The concept of the NOVATERRA Project.

3 NOVATERRA approach in mountain viticulture

The Douro Wine Region (DWR) in Portugal, a mountain viticulture region, presents great challenges, both in terms of vineyard management practices, in the adaptation of grape varieties and selection of places to produce different types of wine. Douro viticulture is unique, offering different microclimates, due to its rugged orography and the steep slopes (Fig. 2).

Figure 2. Vineyards with different systems and at different altitudes and slope aspects.

This project intends to significantly reduce the use and negative impacts of contentious PPP for integrated pest, disease and weed management in two of the main Mediterranean crops in Europe: grapevines and olive trees, involving practical and integrative approach, based on a series of multivariate case studies.

In this sense, some NOVATERRA trials are conducted in the mountain wine region of Douro, resulting from three different approaches: to develop novel combinations of alternative products and biological control techniques for plant protection; to optimize the application and dosage of PPP through smart farming technologies and to develop new soil management strategies (Fig. 3). Overall, a total of about 14 hectares are used, providing solid data to NOVATERRA studies meant to advance sustainable mountain viticulture technologies.

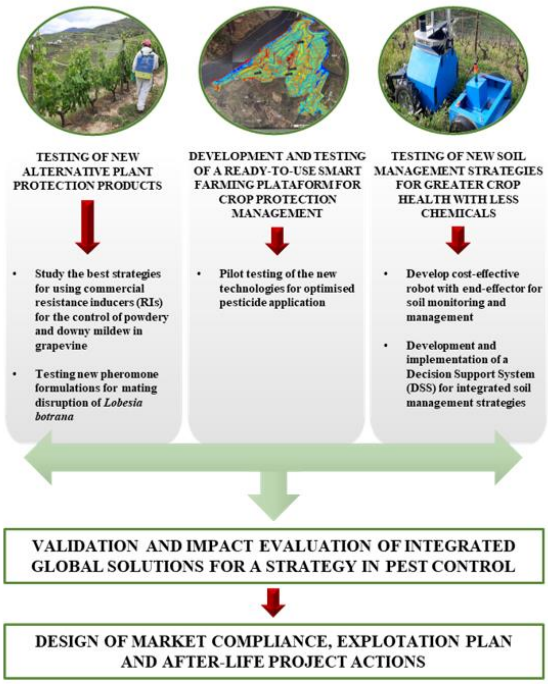

Figure 3. Three different approaches to study under the NOVATERRA project in Quinta do Seixo.

A new agriculture strategy for sustainable crop protection consists of stimulating the plant immune system with elicitors [9,10]. Elicitors or resistance inducers can be described as synthetic or natural compounds produced by plants, microorganisms or from mineral origin, that when applied to a plant species such as *Vitis vinifera*, induce the activation of several secondary biosynthetic pathways [11]. Despite the various studies that have already been done with the elicitor's application in agriculture, and especially in viticulture, under field conditions only few elicitors were shown to maintain the effectiveness of induced resistance.

Other emerging technology, variable rate technology (VRT), allows agronomic management and inputs to be differently applied in time and space [3,12,13]. Vineyards are characterized by high heterogeneity due to structural factors, cropping practices and seasonal weather, accurate canopy characterization being crucial for efficient use of PPP, by means of using the concept of variable rate application (VRA) [14]. VRA technology applies site-specific management strategies to minimize spray losses, using dynamically-corrected dose amounts based on previously collected data, such as canopy size, season, and growth phase of plants [15-17].

Additionally, robotic systems related to mechanical weeding have been heavily investigated, in order, to reduce chemicals use and to help in the reduction of time-consuming activities within the crop production cycle [18,19]. Mechanical weed control can be conducted between the tree/crop rows (inter-row) and within the tree/crop rows (intra-row). The most recent studies of robot systems indicate that the main challenge of mechanical weed control is in the intra-row area, needing accurate guidance systems for not damaging the

trunk/crop. The development of robotic solutions must be adaptable to all agricultural environments, including mountain vineyards built in steep slope hills, as is the case in the DWR (Portugal). Satellite signal blockage, terrain irregularities, steep ground inclinations are some challenges of robotics implementation in such environment.

The project aims to develop an integrated, smart platform able to visualize and analyse data from crop sprayer application in order to assess the efficiency of the crop spraying application. The development of a modular cost-effective robot for mechanical weed removal, capable of working steep slope vineyards and compatible with modern agronomic approaches (https://www.novaterraproject.eu/) is being studied [20].

4 Unveiling NOVATERRA contributions to the Global Biodiversity Framework (GBF)

In December 2022, in Montreal (Canada) the Kunming-Montreal Agreement was signed, becoming the new United Nations Convention on Biological Diversity. This new Global Biodiversity Framework (GBF) proposes 4 goals and 23 targets, in which all 196 countries present in this Convention pledged to comply: the conservation of 30% of land and oceanic ecosystems by 2030 and the full recovery of nature and biodiversity by 2050. Of the 23 targets, NOVATERRA's objectives represent strong contributions to GBF targets 7, 10, 11 and 21 (Fig. 4).

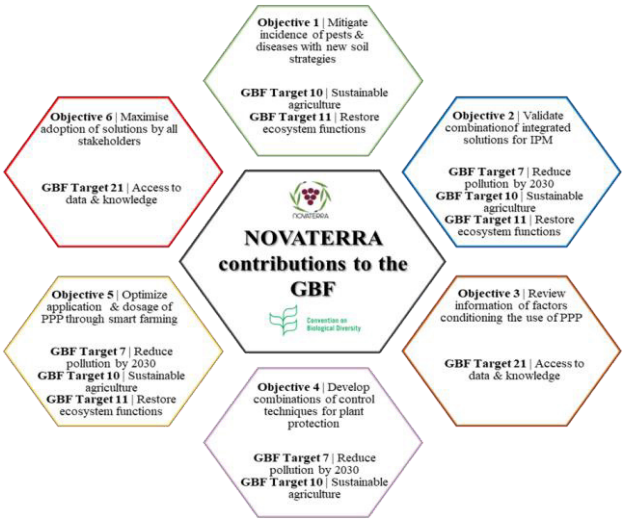

Figure 4. Description of the objectives of the NOVATERRA project within the global framework of biodiversity (GBF).

5 Conclusion

In conclusion, this article highlights emerging technologies for implementing trials in slope vineyards. The novel integration of alternative products and biological control techniques for plant protection, the application and dosage of PPP through smart farming technologies and the development of new soil management strategies, are the main approaches of the NOVATERRA project being trialled in commercial, real-life scale by SOGRAPE. The results of the project trials will enhance the sustainability of the business of grape and wine production in mountain areas. Furthermore, the NOVATERRA project will provide results and knowledge that will support the wine sector's contribution for the global biodiversity framework of the United Nations. The NOVATERRA solutions for the grape and olive sectors in developing nature-positive farming can be deployed all over the world and in many other agrifood sectors. It is foreseen that project NOVATERRA will disseminate all the generated knowledge for a greater reach of the interest of the novel practices obtained.

This work is supported by European Commission's Horizon 2020 (NOVATERRA project) with grant agreement number 101000554.

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