

Application of regenerative agriculture to viticulture: The REVINE project

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Abstract. Conventional viticulture has improved production quality, but its economic costs are often unsustainable. As consumers demand healthier, eco-friendly products, sustainable agriculture is gaining importance. Regenerative agriculture, focused on restoring losses and ensuring long-term sustainability, is being promoted. The REVINE project studies the application of regenerative techniques in vineyards located in Mediterranean countries to enhance soil health and resilience. Key approaches include using plant cover to balance vine nutrition and soil fertility, adopting circular agriculture practices like composting vine shoots to conserve carbon, and improving the soil microbiome with microbial consortia from biofermented products. The project also explores viticultural biodiversity, identifying resilient grape varieties that can withstand environmental stresses. These methods are adaptable to specific conditions, promoting sustainability and environmental protection.

1. Introduction

For sustainable development, it is crucial to strive to meet the economic needs of producers and environmental requirements, which are not opposing but rather complementary, as they are interdependent.

1.1. Increase the sustainability

The agricultural sector is central in this context since it plays a fundamental role in several areas, such as food security, human and animal health, natural resource conservation, and the fight against climate change. To achieve an improvement in these areas, it is important to use adequate inputs to improve overall productivity starting from the available resources.

The approach required should be based on a combination of technological innovation and the spread of knowledge. The efficient use of available agricultural resources would increase productivity and at the same time reduce negative environmental impacts, such as greenhouse gas emissions, loss of biodiversity, and soil erosion.

1.2. Regenerative Agriculture

In recent years, a concept of an agricultural strategy called Regenerative Agriculture (RA) has emerged. Since this practice is still new and evolving, different organizations and individuals have provided slightly different definitions. As a result, the term “regenerative agriculture” is broad and is interpreted in different ways, depending on the practices adopted, the goals, and the regions of the world in which it is adopted.[1,2].

However, it is possible to highlight some key points that generally characterize this form of agriculture: the focus is always on soil regeneration, increase in biodiversity, and improvement of the water cycle and the health of the whole ecosystem.

In a cultivation system, such as a vineyard, it is necessary to apply strategies such as cover crops that are able to store and fix carbon, at the same time increasing the biodiversity and the microbial activity of the soil. According to the assumptions of regenerative agriculture, this ecological system should result in soil capable of good productivity and higher quality production over time.

RA has among its assumptions to regenerate cultivation sites such as vineyards which are usually subjected to intensive farming systems managed with high inputs.

Regenerative Agriculture requires interventions to repair and restore the soil, to provide a solid productive base for future generations. To regenerate we need carbon in the soil, in its different forms ranging from microorganisms, plant and animal cells, and their residues at various stages of decomposition.

A list of practices that are included in RA are:

- a) balancing nutrients in the soil;
- b) maintaining good vegetal cover of the soil;
- c) limiting interventions to the soil (cultivation);
- d) increasing plant and microbial diversity;
- e) supporting the presence of living roots all year round;
- f) integrating and managing livestock.

2. REVINE project

Based on the RA assumptions, the research center of CREA Viticoltura ed Enologia of Turi (Italy), has been the coordinator of the REVINE project (REgenerative agricultural approaches to improve ecosystem services in Mediterranean VINEyards) which aims to evaluate the effects of regenerative agriculture application in vineyards grown in the Mediterranean area. The objectives range from the management of organic carbon and improvement of soil biological activity, through the management of viticultural by-products, plant covers, and microbiome safeguard (of both soil and plants). The project aims to provide indications to producers concerning the procedures that can be adopted for regeneration in vineyards in line with European and Mediterranean expectations for sustainability. (Participating countries: Cyprus, Egypt, France, Italy, Portugal, and Tunisia).

2.1. 2.1 Vineyards and territory

2.1.1. Terroir and microorganisms

According to the International Organisation of Vine and Wine (OIV), “Vitivinicultural *terroir* is a concept which refers to an area in which collective knowledge of the interactions between the identifiable physical and biological environment and applied vitivinicultural practices develops, providing distinctive characteristics for the products originating from this area. *Terroir* includes specific soil, topography, climate, landscape characteristics and biodiversity features.”[3].

Therefore, the *terroir* should be considered as a living element. The vine with the associated fauna and flora are alive and so are the populations of microorganisms present on plants and in the soil, which therefore become an active part of the *terroir*. This declination of the concept of *terroir* is increasingly at the center of attention of the scientific and productive world so much so that the term *microbial terroir* has been created.

Various studies underline how excessive processing, little attention to organic matter, and the presence of synthetic chemical substances reduce the populations of microorganisms, and this would confirm the loss of identity and the general standardization of viticultural products. On the other hand, in various scientific studies, it emerges that, by increasing biodiversity in the vineyard, the quality and character of the wines could be increased.

2.2. REVINE and microorganisms

One of the most important aspects of the REVINE project is the evaluation of the effects of some viticultural practices on the regeneration of microbial biodiversity associated with soil and vines. The living part that cannot be observed with the naked eye, due to its often microscopic size, today becomes visible and understandable thanks to molecular techniques. This step is important to establish scientific reference criteria that can then be used to set regeneration objectives. For this purpose the project is carrying out a characterization of biodiversity associated with soil and plants (bacteria, fungi, etc.) in different wine regions of the Mediterranean countries. This involves a wide range of soil and climate conditions and vine varieties, with particular attention to the rhizosphere.

The practices under evaluation rely on strategies based on natural principles which are useful for the regeneration of vineyard biodiversity and that can also lead to an improvement in plant nutrition, grape quality and the suppression of pathogens and parasites. These strategies include the use of biostimulants and the use of cover crops.

2.2.1. Biostimulants

Concerning biostimulants, the study is aimed at obtaining microbial consortia (SynComs) to be evaluated in terms of their influence on vine productivity improvement and/or tolerance to biotic or abiotic stress. To achieve this, a vast campaign was performed to isolate microbial consortia (from soil and vine tissues), even in extreme environments, including vineyards in arid environments, and at high disease pressure, selecting and isolating from healthy vines despite the presence of pathogens. This long work has allowed us to obtain more than a thousand isolates (both bacterial and fungal) that are stored in a “biobank” created thanks to REVINE project. To date, this microbial bank is among the largest in Europe, which is dedicated exclusively to vines. Each isolate was then characterized for its ability to contain the main vine pathogens, such as botrytis, downy mildew, black rot, and wood pathogens linked to esca syndrome. The isolates were also studied for their ability to resist salinity, water shortage and tested for their ability to promote growth and productivity. To go further the laboratory step, these isolates were then formulated and inoculated in vine shoots to observe their responses also in field conditions. Biostimulants originating from “local” microbial formulations can be particularly useful in regenerating soils compared to pre-packaged formulations. In this perspective, the evaluations in the project also

concern the combined use of SynComs with compost and *biochar*.

2.2.2. Biochar

Furthermore, particular attention has been given to the implementation of circular economy with the reuse of vine by-products to obtain products with high biological value such as compost and *biochar*. For products with high carbon stability deriving from vine shoots, such as compost and *biochar*, production and evaluation protocols have been developed. *Biochar* is characterized by a high exposed surface and high porosity. Its structure makes this material capable of retaining water and being a substrate for microbial growth.

2.2.3. Compost

The compost obtained from vine shoots and residues of green legumes is characterised by its high nutritional capacity and high microbial load.

2.2.4. Cover crop

Another strategy being evaluated is the presence of vegetal cover in vineyards. A grassy vineyard can significantly reduce soil erosion, and vegetal covers provide various ecosystem advantages, such as improving water retention, deep rainwater infiltration, increasing soil organic matter, and carbon sequestration. The vegetal cover also contributes to the presence of natural antagonists of vine parasites and in increasing beneficial microbial biomass. Since grape quality components vary greatly, further developments in this area could lead to a better understanding of microbial populations and their composition in the vineyard, resulting in table grapes and wines that are more closely linked to the region.

3. Conclusions

The REVINE project highlights the importance of practices such as viticulture by-products management, cover crops, and microbiome maintainment to regenerate the soil quality, improve plant nutrition, and reduce environmental impacts. In this context, a specific OIV resolution on Regenerative Viticulture practices could be considered to guide producers in the transition to a more sustainable and resilient production model. Such a resolution could include:

- a) supporting the regeneration of soil biodiversity through the reduction of intensive ploughing and the use of biostimulants based on local microbial consortia, favoring the production of quality grapes closely linked to the terroir.
- b) establishing the recommendation to use cover crops in vineyards to improve water retention, prevent soil erosion, and increase carbon sequestration capacity.
- c) promoting the reuse of vine by-products, such as shoots and green residues, for the production of

compost and biochar, which are essential to improve soil structure and increase carbon content.

- d) To incentivize international research projects, such as REVINE, which are aimed at improving the understanding of the soil and plant microbiome, to establish benchmarks for soil regeneration and the sustainability of viticultural practices.

The OIV, as an international reference body for the vitivinicultural sector, has the opportunity to lead this change through a resolution promoting regenerative viticulture as a tool to ensure the environmental, economic, and cultural sustainability of the sector, providing a solid production base for future generations. This resolution would allow the dissemination of virtuous and scientifically based practices throughout the world, helping to improve the resilience of the viticultural sector in the face of climate and environmental challenges.

4. Acknowledgements

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5. References

1. Moyer, J., Smith, A., Rui, Y., Hayden, J. (2020). Regenerative agriculture and the soil carbon solution [white paper]. (https://rodaleinstitute.org/wp-content/uploads/Rodale-Soil-Carbon-White-Paper_v11-compressed.pdf)
2. Savory, A. and Butterfield, J. (2016). Holistic Management: A commonsense revolution to restore our environment, 3rd Edition. Island Press, Washington DC.
3. Definizione di "terroir" vitivinicolo
RISOLUZIONE OIV/VITI 333/2010
DEFINIZIONE DI "TERROIR" VITIVINICOLO