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Long-term adaptation of European viticulture to climate change: an overview from the H2020 Clim4Vitis action

>>> Climate change is a major challenge to viticulture worldwide. The adaptation potential of the different strategies to cope with climate change still embraces many uncertainties (e.g., unpredictable social-economic developments and land-use changes), particularly in the long-term. However, adaptation strategies adjusted to local terroirs and regional climate change projections will contribute to the sustainable development of the winemaking sector. The Clim4Vitis action (https://clim4vitis.eu/) recommends some guidelines for long-term adaptation (Figure 1). <<<

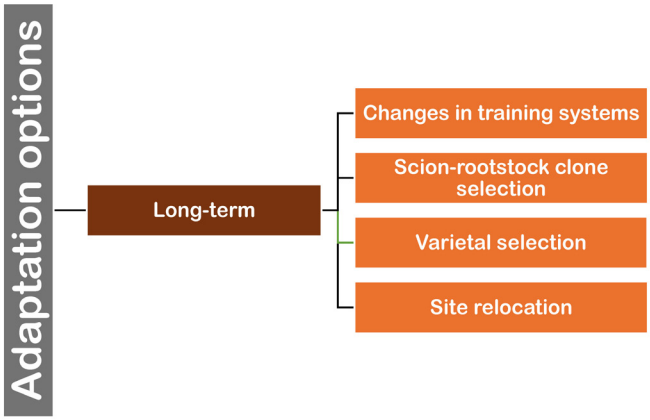

Figure 1. Summary of long-term adaptation options to mitigate climate change impacts on viticulture.

Long-term adaptation measures refer to those that require transformational options or structural changes. Winegrowers tend to be reluctant to apply such measures; compared to short-term adaptation they typically require more investment and significant changes to common practices, and they need to be implemented over relatively long temporal horizons, dealing with many uncertainties about the future. Some possible measures are outlined below.

■ Changes in training systems

Changes in training systems can provide significant adaptation potential. Given the projected warmer and drier climate in some regions (e.g., Mediterranean region), the training system that should be prioritised is one that can reduce crop water demand with increased drought resistance, while trying to maintain adequate berry quality and vineyard productivity[1]. For instance, the *gobelet* training system was frequently adopted in dry Mediterranean areas to limit vine water use, by lowering the leaf area per hectare and limiting the demand for photosynthesis and transpiration[2]. However, the *gobelet* system has been gradually abandoned in recent years owing to difficulties in applying mechanical harvesting[1]. In some cases, training systems can also be modified to delay phenology. Molitor *et al.* (2019)[3] demonstrated that the low input training system of the semi-minimal pruned hedge, along with non-thinned treatment, can delay bunch rot formation and fruit maturity, thus opening a new opportunity for adaptation in both cooler and warmer viticulture European regions. Another way of modifying the training system for adaptive purposes is to increase trunk height to avoid the impacts of excessively high temperatures in the bunch zone; this practice is particularly effective in limiting the maximum temperature on dry and stony soils[1]. Moreover, changes in training systems often imply changes to other associated aspects. Planting density, row distance and orientation, as well as the distance between plants, are known to influence canopy geometry and light interception, which should be optimised along with the training systems to improve adaptation potential[2].

■ Scion-rootstock clonal selection

The selection of appropriate plant material is a major recommendation for adaptation to climate change. Generally, the adaptation goal is to maintain the local wine typicity which is a reflection of the local variety and regional specificity. It is recommended to exploit clonal variability (both scion and rootstock clones), because for most varieties there are still differences in maturity timing of to 8 to 10 days for different clones of the same variety[1]. Late-ripening clones are grafted onto the same variety, so that the wine typicity will not significantly change and the fruit ripening process can be delayed in order to cope with advanced phenology under rising temperatures[4]. Proper rootstock selection is also key to long-term adaptation, as it can increase the plants' resistance to many biotic and abiotic stresses; for example, existing rootstocks of 140 Ruggeri or 110 Richter are highly drought-resistant[1, 2, 4]. Corso *et al.* (2016)[5] revealed a new rootstock, designated as M4, that can enhance plant tolerance to water stress. However, the drought tolerance of rootstocks is highly variable among regions and deserves more attention in future research.

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■ Varietal selection

From a long-term perspective, fruit ripeness can be considerably delayed by introducing late-ripening varieties to some important winemaking regions (e.g., Bordeaux)[1]. When searching for late-ripening genotypes that produce wines with no alteration to their quality, Duchêne *et al.* (2010)[4] analysed a range of phenological stages that can be found in the progeny of a Riesling × Gewurztraminer cross. Nonetheless, replacing a current variety with a new one is challenging in many European wine regions, where the prestige and sensory properties of many terroir wines rely on specific varieties, and any abrupt changes may imply significant financial risks[2]. To overcome this issue, it is important to help consumers gradually adapt to different wine styles and characteristics; for example, by cultivating better-adapted varieties and mentioning them in wine labels as being more climate-resilient and environmentally friendly[2]. On the other hand, the selection of new varieties should also focus on their drought and heat tolerance. The cooler northern European winemaking regions can already benefit from a wide range of varietal choices that are currently available in southern Europe, whereas the latter should strive to find new varieties with improved resistance to future warmer and drier climates[6].

■ Site relocation

In regions where viticulture may become economically or environmentally unsustainable, vineyard relocation is a possible long-term adaptation option. Decreases in the suitability of some winemaking regions in southern Europe are likely to occur under projected future climate[6, 7]. Accordingly, it has been suggested that vineyards be relocated to cooler coastal areas, to sites with higher elevation, latitude or less sun-exposed locations, such as north-facing slopes[1, 2]. However, the relocation option is generally considered as a last resort and should be systemically assessed by, for example, taking into account the spatial variability of local climate, topography, slope and economic suitability[2]. For instance, when vineyards are moved to a higher-elevation area the risk of exposure to excessive UV-B radiation can be noteworthy, which may jeopardise berry composition and wine quality[1]. Nevertheless, the detailed assessment of local microclimates is crucial for a successful relocation adaptation; for example, in the Douro and Port Wine Demarcated Region, where the temperature variations in elevation are quite significant (hilltop temperature can be several degrees lower than the temperature in the low-elevation areas close to the Douro River), winegrowers can design and adapt their cultural practices according to the wide range of microclimates. ■

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