How to measure and manage the soil effect in terroir expression

Sourced from the research article “Soil-related terroir factors: a review” (OENO One, 2018).

Terroir relates the taste of wine to the place where it was produced. It involves the influence of climate, soil, cultivar and viticultural practices on wine. A lot of progress has been made over the years in understanding how soil can shape the quality and style of a wine. To observe and explain the soil effect, it needs to be broken into measurable factors. Once these are quantified by appropriate approaches, a terroir can be mapped and managed. By fine-tuning the choice of plant material (rootstock and variety) and viticultural techniques according to local soil conditions, it is possible to optimise terroir expression.

## Soil effect in terroir expression

It is surprising how different vineyard soils can be. Great wines can be produced on acidic soils with a high gravel content, or on calcareous or heavy clay soils. It is not possible to define a potential high-quality soil by its composition. It would be tempting to conclude from this diversity that soil does not matter. However, a study conducted on 500 vineyard blocks located in famous winegrowing estates in the Bordeaux area has shown that soil type does, in fact, impact wine quality; the soil type significantly influenced the probability that the grapes would be selected for the first quality wine on these estates. Although this study proves that soil type has an impact on wine quality, it does not explain the mechanisms involved. Rocks are studied by geologists and soils by soil scientists; these scholars give names to rocks and soil types and produce maps. These maps provide useful information on how rocks and soils are distributed over a given area, but they cannot explain the process by which they might impact wine quality. To do so, the effect of the soil needs to be decoupled from climate and broken down into measurable units. If soil influences wine quality, this effect is necessarily mediated through the vine. Soil modifies vine phenology and development, as well as ripening traits and grape composition. As a result, wines produced on different soils vary in sensory attributes, because the composition of the grapes changes according to the soil type on which they were produced. To obtain an insight into how soils influence wine quality, we need to understand how the soil influences vine phenology, growth and grape composition at ripeness.

## Back to basic agronomy

Like any plant, vines respond to their environment. Agronomists know that light, temperature, minerals and water resources are needed to make plants grow and for fruit to ripen. In any given place, these environmental resources are available in different proportions: more or less light, higher or lower temperatures, more or less water, and differing availability of specific minerals.

## Assessment of soil temperature, nitrogen and water availability

Soil temperature can be measured with specific probes, but it is not easy to integrate results spatially (over the field) and temporally (over the season). The measurement of soil resistivity can be considered as a proxy for soil temperature: soils with high resistivity are generally coarse.
textured and warm, and soils with low resistivity contain more clay and are cooler (Figure 1). Vine water status can be measured by δ¹³C on grape sugars (see van Leeuwen et al., 2009 for methodology¹). By measuring δ¹³C on samples taken from a regular grid of 8 - 10 points/ha, vine water status can be mapped (Figure 2). Vine nitrogen status can be assessed by measuring yeast available nitrogen (YAN) in grapes. These measurements can be carried out on the same samples as those collected for δ¹³C analyses, and results can subsequently be mapped (Figure 3). By combining soil resistivity, water status and nitrogen status maps, a very precise assessment can be made of the major factors which drive terroir expression.

**No myth**

Terroir expression is considered by some authors as a myth². We disagree. The terroir effect can be observed and explained when the multiple factors driving terroir expression are hierarchised and broken down into measurable units. Because terroir is highly variable in space, the tools used for measuring these units should ideally be able to produce maps. Once key factors are quantified and mapped they can be used by growers to fine-tune the choice of plant material and viticultural techniques in order to optimise terroir expression.

**Management of terroir**

Growers can optimise terroir expression by choosing plant material and viticultural techniques according to the set of locally available resources. Rootstocks need to be adapted to soil type. High vigor rootstocks perform better in poor and shallow soils, and low vigour rootstocks in rich and fertile soils. On cool soils, berries risk not attaining full ripeness; hence early ripening grape varieties will perform better. On warm soils, grapes may be too high in sugar, too low in organic acids and show undesirable cooked fruit aromas; these pitfalls can be avoided with late ripening varieties. White varieties perform better on soils with medium to high water and nitrogen availability, while red varieties will produce more concentrated wines on soils where vines undergo water deficit and low nitrogen. The training system should be chosen as a function of available water. High density plantations will adapt to soils with high water holding capacity, while the detrimental effect of excessive water stress can be mitigated with low density plantations, or goblet trained bushvines³. Vineyard floor management and fertilisation practices can fine-tune the amount of soil available nitrogen. Cover cropping can create a competition with the vines for nitrogen and lower vine nitrogen status, while nitrogen deficit can easily be compensated for via organic or mineral fertilisation.

Figure 2. Vine water status map created with δ¹³C measured on grape sugars (8 samples/ha). The south-western part of the vineyard experiences significant water deficit, while there is no water deficit in the northern-most block. It was shown that δ¹³C correlates well with water potential⁴.

Figure 3. Vine nitrogen status map created with YAN measured on grapes (8 samples/ha). Vine nitrogen status is moderately high in the south-western block, while it is very low in the northern-most block.

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1. VAN LEEUWEN C., ROBY J.-P. and de RESSÉQUIER L., 2018. Soil related terroir factors, a review. OENO One, 52, 173-188.
8. VAN LEEUWEN C., PIERI P., GOWDY M., OLLAT N. and ROBY J.-P., 2019. Reduced density is an environmental friendly and cost effective solution to increase resilience to drought in vineyards in a context of climate change. OENO One, 53, n°2, 129-146.