In the picturesque valley of Napa, California, visitors enter the tasting room at Etude to sample an array of wines. Along with the bottles of reds and whites, they find an artistic and educational addition to the room. Cabinets lining one wall hold displays of the soils in which the vines that produce Etude's wines are grown. The displays offer tasters a look at a part of winemaking that is usually hidden—the soil layers deep below the vineyard surface.

"We brought our soils into our tasting room because we can't bring all of our customers out to the vineyard," says Franci Dewyer, Etude's viticulturist. "And even if they were in the vineyard, they couldn't see the soil profiles."

With the addition of the soil profile displays, tasters are able to learn about the wine and the soil that supports the vines and grapes. But with all that goes into producing a bottle of wine, what role does the vineyard soil actually play?

The concept of terroir (often translated as a “sense of place”) has grown in popularity in recent years. Terroir is a set of characteristics, such as landscape, climate, and soil types, that are said to create the unique wine of an area. While each of those components do affect vineyard planning, grape selection, and vine growth, many soil scientists warn that the idea that soil type directly drives the flavor of a wine is unfounded.

“I’m going to throw doubt on the notion that soils are what drive the flavor of wine, the flavor in the bottle,” says John Havlin, professor and extension specialist at North Carolina State University. “The plant takes up water and nutrients and has to make flavor compounds. The plant cannot take up compounds from the soil that you would consider flavor.”

**Climate Drives Flavor**

Instead, Havlin says, the climate around the vineyard drives the flavors of the wines much more than the soil type. The amount of rainfall during a season, the rainfall distribution, and the temperatures that the vines encounter can all drastically change the amounts and types of flavor compounds and the final wine in the bottle.

As an example, Havlin suggests thinking about the differences in a single wine made from the same vines from one year to the next. A wine drinker buys a 2008 Cabernet Sauvignon from his favorite vineyard. The price is high, but so is the quality. He decides to buy more, but the store only has that wine in the 2009 vintage. He buys that instead, but it is of much poorer quality—and cheaper—than the 2008 wine. “So what’s driving the change in quality of that wine between 2008 and 2009?” asks Havlin. “The soils never changed. But the growing conditions were different.”

The soil profile displays at Etude allow tasters to learn about the wine and the soil that supports the vines and grapes. The importance of climate when growing quality grapes can also be seen by comparing different areas of the country. Havlin says that while grapes grown in Napa, California soils could be grown to produce quality wine in North Carolina soils, the climate won't allow it. Napa Valley has warm days during which the grapes produce good flavor compounds. At night, the temperatures drop, slowing the plant’s metabolism and keeping flavor compounds concentrated in the grape. But in North Carolina, temperatures stay high at night, and some of the good flavors in the grapes are lost as the fruit continues to metabolize. It is the climate, not the soil, then, that prevents some quality wines from being produced in North Carolina.

In fact, as more winemakers set up shop in North Carolina, they are doing so at higher elevations. “You add another thousand feet in elevation, and nighttime temperatures are going to be cooler,” Havlin explains. “That’s really what you want—to shut down the plant at night, so it doesn’t metabolize all those flavor compounds.”
Soils Support Vine Growth, Grape Production

But if climate is so vital to wine flavors, why are vineyards, like Etude, trying to educate tasters about the soils? It’s because soils do play very important roles at vineyards—not by directly lending flavors to the wine, but by supporting vine growth and grape production with water and nutrients. The need to fully understand soils at a vineyard has even led many winemakers to consult with soil scientists when assessing a potential site for a vineyard or looking for ways to improve vine growth.

John Havlin, professor and extension specialist at North Carolina State University, says soils may not directly lend flavors to wines, but they do play very important roles at vineyards by supporting vine growth and grape production with water and nutrients.

James Fisher, a soil scientist at Soil Solutions, LLC, says he looks at three major things when assessing a vineyard site—weather patterns, terrain, and soil. The soil analysis identifies the different horizons and measures multiple characteristics of the soil including color, texture, depth, consistency, and parent material.

“From that information, I can tabulate a soil profile analysis and create a soil map,” Fisher explains. “The map will show the different soils and how best to maximize them, and from there, I outline the vineyard plots accordingly.”

Deciding which vines to grow in which soils of a vineyard can be a complex process, partly due to the different rootstocks used in grapevine production. Rootstocks are established root systems onto which the scions, the parts of the plant that will produce the grapes, are grafted. The practice of grafting vines onto different rootstocks began in Europe in the late 1800s. After an aphid-like insect, called Phylloxera, decimated their grapevines, growers realized they could graft their grapes onto rootstocks that were resistant to the pests. Now, grafting is a common practice, and it can be used to customize a vine to match the soil.

Some rootstocks have adaptations for different soils,” says Stan Grant, soil scientist at Progressive Viticulture. “Some do well on acid soils, some do better on alkaline soils, and some have salinity tolerance.”

Rootstocks can also be used to control vigor—the propensity of the vine to grow. Vigor is not necessarily a good thing for grapevines. Soils with high levels of nutrients, for instance, can lead to high vigor, which causes excessive growth of grapevine vegetation. This means that the plant is putting less energy into production of the grapes, and the quality of the fruit suffers. Conversely, if a vine has insufficient vigor, little vegetative cover can mean scorched grapes from too much sunlight.

“A Little Bit of Stress is a Good Thing

In addition to controlling vigor, one of the most vital factors in creating an ideal environment for wine grape production may seem counterintuitive—the vines need to be stressed. Unlike many other crops, quality grapes are grown under stressed conditions. In fact, one of the most important factors when planting grapevines is a well-drained soil that provides moderate water stress.

This is especially important for deep, dark reds. “Zinfandel vines are not planted in the flat, bottom portions of Napa Valley,” Havlin explains. “They’re on a rocky hillside where the water is less and the nutrient availability is less so that the plants are stressed.” On these soils, water stress means that the flavor...
compounds will become concentrated, creating a more ideal grape for that bottle of Zinfandel or Cabernet Sauvignon.

The importance of stressing vines is recognized throughout the world. “In Europe, they tend to grow vineyards on their poorest soils. The vines suffer moderate water stress, and they get the intensity of color, flavor, and aroma,” Grant explains. “They think we’re foolish in California because we commonly grow grapes on highly productive soils.”

So what kinds of compounds are concentrated when vines are stressed? One important compound that is easily recognized, especially in red wine, is tannin. Tannins—used to tan leather—give red wine its astringency or drying quality. While some tannins are made in the seeds, the smoother, more desirable tannins are made in the skins. “If we have water stress,” Grant says, “we usually get more of the skin tannin.”

The importance of soils in vine growth and grape production, then, is clear. The ideal soils for grape growth are well drained with some—but not too many—nutrients. Also, Havlin says, there should be enough topsoil to establish growth, but it’s better to have rocky soils beneath that where little water and nutrients can be stored.

**What Do You Do When You Don’t Have Ideal Soils?**

But not all soils are that well-suited for grape growth. Luckily, when ideal soils aren’t an option, there are ways to amend the soil or change the growing conditions. In addition to rootstock selection, pre-planting activities or in-season inputs can be adjusted to adapt to a range of soils. “Even things that could be deal breakers,” Fisher says, “there are ways to modify them.”

One of the most obvious ways of controlling vine growth in a variety of soils is through irrigation. Because climate has significant impacts on grape production, irrigation allows for healthy vine growth in areas with low rainfall or sandy soils that store little water. Some winemakers even prefer soils that store little water because then irrigation can be used to create the ideal stressed environment for quality grape production. That approach, called regulated deficit irrigation, started in Australia, gained traction in the United States in the mid-1990s, and is now common practice at many vineyards.

Advancements in irrigation practices, namely drip irrigation, have also provided a means to provide fertilization and irrigation at the same time—a method called fertigation. Fertigation technologies can be used to apply necessary water and nutrients to vines in a way that better addresses changes in nutrient requirements throughout the growing season.

“Fertigation allows us to apply mineral nutrients in small quantities in proportion to the demand during that period of time,” Grant explains. “The ability to fertigate is a very powerful tool.”

As new vineyard management technologies and practices are developed, the need for technical expertise such as that provided by soil scientists will only increase. While links between soil types and specific wine flavors are dubious, there is no doubt that soils are a vital component of winemaking. Understanding the relationship between grapes, vines, soils, and climate will continue to open new doors in the viticulture world.

“It is necessary to understand what kind of soil you’re working with and how the vine interacts with the soil and the climate,” Havlin says.

And it is sharing that understanding with wine consumers that drove Etude to create their soil display. “We want customers to walk away with a sense of the uniqueness of our vineyards,” Dewyer says. “So, we have to include our soils as part of our story.”

To learn more about Etude, see https://www.soils.org/publications/sh/articles/54/4/sh2013-54-4-rc1.