Achieving Optimum Terroir

Defining quality in fruit production is perhaps as difficult as achieving it. Most producers use simple sugar or ripeness evaluations to determine harvest dates and cosmetic considerations to judge quality. Flavor, storage quality, pest and disease resistance, and other subtle factors are slowly being added to the list of research priorities, and more attention is directed towards soil fertility and fertilization. The wine industry has traditionally been the leader in flavor and quality research. Seguin, in "Terroirs and Pedology of Wine Growing" (1986), presented a very good comparison of the finest wine growing areas of Europe. Sorting out the major factors: climate, training systems, cultivars & rootstocks, soil characteristics, vine nutrition, and water relations proves to be very complicated. The obvious importance of climate led California researchers to distinguish five viticultural zones. They generally stressed temperature over fertility for characteristics of wine. Seguin emphasized the lack of experience in the USA and Australia relative to France, which has had hundreds of years working with the climate-soil-cultivar ecosystem.

Most viticulturalists would probably agree that: "Good terroirs are those permitting complete but quite slow maturation of cultivars" (Sequin, p. 861). This is difficult to achieve in the hotter grape growing regions, or in extreme climatic conditions such as drought or heavy rainfall. The other important factor Seguin points out, which wine growers in northern California also know, is that production must be limited; large yields are traditionally associated with poorer juice quality. Excess nitrogen and water have long been known to result in thinner skinned fruit, larger yields, and less flavor.

Topography is definitely important: slopes and hillsides produce better quality than deeper bottom land. Thinner soil allows easier control of both water and nitrogen; deep fertile soils are associated with higher yields, plumper grapes, and less flavor. Both in California and France, premiums are commonly paid for fruit from the hillsides.

From a soil analytical viewpoint, characteristics of the best terroirs vary all over the world. Seguin mentioned the only soil fertility factor which is commonly associated with quality: limestone content. Many of the world's finest vineyards are located on calcareous soils. However, he also noted that many fine vineyards are situated on acidic soils, and concluded that "quality wines are produced on acidic, neutral and alkaline soils" (p. 862). Excellent wines are produced on the following geological formations: chalk, marl or sandstone with active calcium carbonate; clay; sand; schist; and granite.

Soil structure has an important role in producing fine wine (Seguin, p. 864):

> In a majority of cases, the best terroirs are characterized by a high degree of macroporosity, permitting rapid water percolation, and thereby preventing stagnation at root level. Coarse soils (gravel-sand) are of course permeable; however clayish soils are only porous when there is sufficient humus (at least 10% of clay content) and calcium in abundance to flocculate the clay- humus complex (one must remember that many quality terroirs are situated on parent material containing active calcium carbonate).

Good soil structure allows the roots to explore more area and find nutrients not available in these poorer topsoils. It insures that during wet weather the soil will drain as well as possible, minimizing stagnation and anaerobic conditions. Stagnate conditions in the root zone result in reactions that produce noxious compounds in the soil and off flavors in the fruit. Furthermore, porosity gives the vines a more even water supply. Thus, shallow soils may be infertile (not suited for high yielding or protein producing crops), and yet still produce high quality grapes. They get a wide range of mineral nutrients without taking up large quantities of nitrogen and growing too vigorously.

The deeper, fertile soils are best suited for higher yields or crops that need high levels of nutrients. Often roots of grapevines cannot avoid taking up excess nitrogen under these conditions. These soils are better suited for pears, apples, cherries, and other fruits. To grow wine grapes on these more fertile soils, various training methods and careful management are needed to regulate vigor and crop size. For these soils, soil mineral balance and structure are very important for pest and disease management and quality, but higher vigor can be beneficial. For all soils the BCSR model addresses soil structure better than the pH theory.

Water relations are very important for early growth and ripening of all fruits, but are essential for wine grapes. High to adequate amounts of soil water are best followed by declining levels as berries ripen. Too much water

at harvest dilutes flavor; too little shrivels grapes and can cause bitterness. Seguin rated soil structure and its contribution to alleviating drought or heavy rainfall as one of the major factors in good terroir. I also stress its importance in nutrient and disease management.

Seguin concluded that chemical properties are not crucial if: 1) excessive vigor and production are avoided and 2) vines do not suffer from toxicity or a serious lack of any element. He suggested "one could limit oneself to restoring to the soil those elements which are transferred through harvesting or lost by being washed away (maintenance additives)" (p. 865). This strategy has worked well in northern California: major minerals are balanced using the BCSR model; micronutrients are adjusted for minimum SLAN levels, and nitrogen is the last nutrient considered. Minimum amounts of nitrogen are adjusted using tissue analysis and field observations. For all the other fruits a higher nitrogen allowance is used, however much less is applied than commonly used by the industry. Deficiencies, toxicities, and vigor of trees and vines are monitored and conditions optimized for any given climate, season, or locale.

Seguin's use of the "ecogeopedological milieu" (p. 861) was similar to the approach of Albrecht: they both considered bioclimatic units distinguished by soil, agronomic and climatic characteristics. Although Albrecht worked with pasture, feed, and grain crops, I have found that keeping the top 12" within the balance recommended by BCSR results in superior fruit production. By quantifying and categorizing northern California soils using the BCSR model, I have provided researchers and practitioners with a valuable tool for the pursuit of growing practices which make sense and produce healthy, flavorful results.