CHAPTER SEVEN

# "We Are Both Hosts"

## *Napa Valley, UC Davis, and the Search for Quality*

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> Napa Valley's success is synonymous with Davis's success.
>
> —*Andy Hoxsey (2012), Napa grape grower and winery owner*

In the minds of American wine drinkers, the Napa Valley is synonymous with fine wine, an American Burgundy and Bordeaux somehow compressed into a narrow valley about a mile wide and only thirty miles long, stretching from San Pablo Bay and the city of Napa in the south to Calistoga and Mount St. Helena in the north. Here we will use *Napa* to mean both Napa County and the Napa Valley, an American Viticultural Area located within Napa County. Napa's dominance in the image of California wine is confirmed by a variety of statistics reflecting the price premium paid for Napa vineyard land, grapes and wine. Although its approximately 45,000 acres of vineyards account for only 8 percent of California's wine grape acreage, and just 4 percent of the state's wine grape production, Napa vineyards regularly garner over 20 percent of the more than $2 billion dollars of wine grape revenue each year (see Figure 7.1). In the first decade of the twenty-first century, Napa Cabernet Sauvignon has averaged well over $4,000 a ton, more than four times the state average for the variety, and vineyards in the heart of the valley routinely sell for over $200,000 an acre, as compared to $20,000 an acre forty miles away in Lodi. With over 700 wine producers, Napa accounts for approximately 20 percent of California's 3,300 wineries, although responsible for 4 percent of California grape production (Wines and Vines, 2010). Wine grape sales accounted for over 98 percent of all of Napa's $0.5 billion agricultural revenue in 2010 (Napa, 2010). Global retail sales of Napa wines were about $4.4 billion dollars in 2011. Napa wine tourism added an estimated $1 billion (Stonebridge Research Group, 2012).

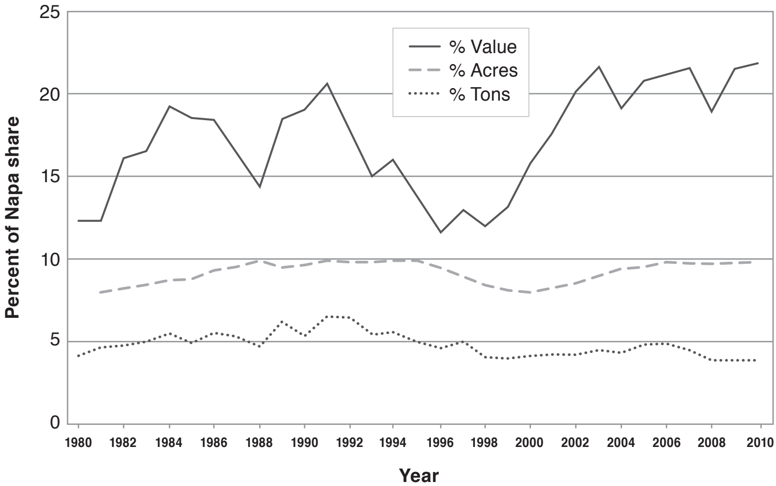


FIGURE 7.1. Napa share of California state total as a percentage.

SOURCE: California Department of Food and Agriculture Grape Crush Report and Grape Acreage Report, Years 1980–2010.

The growth of the wine industry in Napa is a result of many factors, including natural endowments such as soil, climate, and proximity to a major urban center; early and constant promotion by the Napa Valley Vintners' Association; and a competitive commitment to high quality by winery owners that has led to investment in the science of grape growing and winemaking, employment of a trained cadre of progressive winemakers and vineyard managers, and early adoption of innovations. Much of the science, and most of the winemakers and vineyard managers, are the products of the University of California at Davis, located just forty-five miles east of the Napa Valley. This reality was recognized by Robert Mondavi in 2001, when he gifted $25 million to UC Davis to create the Robert Mondavi Institute for Wine and Food Science. Mondavi reminisced that he had gone to Stanford, but that his "bible" had been *Amerine's Principles and Practice of Winemaking*.[1] As he put it, "I learned to make wine only because I followed that book so religiously. I succeeded because of that" (UC Davis News, 2001b). In speaking of his gift he commented: "UC Davis has been a true partner in building the international reputation of the California wine industry . . . We are now leading the way with UC Davis graduates at the helm of many of our finest wineries, Robert Mondavi

Winery included. We are greatly honored to support UC Davis with new facilities that ensure its position as the world's leading educational center for viticulture, enology and food science" (UC Davis News, 2001a).

UC Davis cannot claim credit for the diversity of soils or for the moderate daytime temperatures and cool nights that allow Napa grapes to achieve full varietal intensity and flavor, but application of Davis research both in grape varieties and rootstocks and in canopy and irrigation management has allowed Napa viticulturists to maximize Napa's natural endowments of climate and soil. Nor can Davis take credit for the entrepreneurial and promotional spirit of Napa's vintners and winegrowers, although it is certainly proud that many of the founders of Napa wineries in the 1970s and 1980s traveled to Davis to attend "short courses" on the science of grape and wine production and the economics of small wineries. What Davis can claim is a significant influence on the development of the Napa Valley, and, more broadly, the California wine industry, in four broad areas: research, teaching, viticultural extension, and professional continuing education. This chapter draws on interviews with UC Davis faculty and Napa winemakers, viticulturists, and winery owners to explore the role of the UC Davis in the development of the Napa Valley.

## "It Was the Wild West": Early Days and the Search for Quality

Napa has enjoyed a long history of producing quality grapes and wine. *Vitis vinifera*, the European wine grape, was introduced into the Napa Valley before statehood in 1850 and prospered in Napa's Mediterranean climate. By the 1880s, Napa wineries had won major awards at international competitions, and Napa was generally recognized as the producer of California's best dry wines, with well over 100 wineries spread throughout the valley (Lapsley, 1996; Sullivan, 2008; Heintz, 1990). Within a decade, however, an epidemic of phylloxera, an insect that kills *V. vinifera* by feeding on its roots, and the general economic downturn caused by the depression of 1893 combined to reduce dramatically the profitability of grape growing and wine production in Napa and Sonoma. Some vineyard owners went bankrupt; others turned to more profitable crops such as prunes and walnuts.

Prohibition, which ended the commercial production of most wine during the 1920s, actually spurred grape production throughout California, including Napa. Although commercial wine production was curtailed, home wine production was allowed, causing a huge increase in that area. However, the demand was for grapes with thick skins that could survive shipping by rail to the East Coast and for grapes with high levels of tannin and color, such as Petite Sirah and Alicante Bouschet, which could be ameliorated with water to increase volume, rather than for varieties such as Cabernet Sauvignon or Pinot noir. For Napa, the legacy of Prohibition in the 1930s was vineyards grafted to high-yielding but lower-quality varieties and wineries that had not produced wine for over a decade.

Following the repeal of Prohibition in December of 1933, Napa winery owners were surprised and dismayed that commercial demand was for fortified wines, rather than for dry table wines.[2] Fortified wines, such as port and sherry, were manufactured in California's central valley from inexpensive grapes grown in irrigated prolific vineyards yielding eight to ten tons per acre. The main flavors of these fortified wines derived from oxidation, alcohol, and sugar. The varietal characteristics of the grapes used in fortified wine production were relatively unimportant. Located in a cool coastal environment, Napa vineyards produced grapes with higher levels of color, acid, and varietal intensity than did San Joaquin valley vineyards, but Napa's unirrigated vineyards yielded only two to three tons per acre. Without receiving a significant premium for producing higher-quality fruit and wine, Napa growers found it impossible to compete with producers from California's Central Valley. Napa's most famous wineries, such as Beaulieu, Inglenook, Beringer, Larkmead, Martini, and Charles Krug, successfully created niches for themselves by producing and bottling higher-priced table wine in a market dominated by fortified wines. During the decades of the 1940s, 1950s, and 1960s, these wineries produced a disproportionate share of California's higher-quality wines, resulting in an association of Napa with wine quality in the minds of discerning wine drinkers. Yet, despite the commercial success of Napa's quality wine producers, the market for higher-quality wine was still quite small in the United States, and grape and wine production slowly declined in the Napa Valley, reaching its nadir around 1960. Until the wine revival of the late 1960s, most of Napa's grape crop was crushed at the two cooperative wineries in St. Helena and then shipped in bulk to Gallo, which blended the Napa wine with wine from the Central Valley (Lapsley, 1996).

Quality is a difficult concept to define in wine, but because the price differentials received by Napa wineries and growers relative to other regions are predicated on Napa's production of higher-quality grapes and wine, the concept of quality is extremely important to the history of the Napa Valley. In one sense, *quality* means degree of excellence. But as cultural notions of what is "excellent" change over time, so must a notion of quality. A "quality" can also mean an "attribute," and wine quality (excellence) is a result of at least three interactive factors that affect the attributes of grapes and wine. First is environment. Where grapes are grown does affect the attributes of the grapes. Generally speaking, a grape variety such as Cabernet Sauvignon, when grown in a moderately cool area, possesses greater color, acidity, and varietal intensity than does the same variety when grown in a hot area. The Napa Valley is an exceptional place to grow grapes. It is sufficiently warm to ripen grapes fully but cool enough to maintain full varietal flavor. Although there is virtually nothing a grower can do to change the environment, he or she can choose which varieties to plant in a given location as well as deciding on vineyard orientation, trellising systems, and planting density. All of these variables affect grape attributes and resulting wine quality.

If environment is a given, two human factors also effect the attributes of grapes and wine. The first factor is how a grape is grown. Human decisions include crop level (yield), levels of light and air penetration (trellising and canopy management), and amounts and timing of irrigation and fertilization. Each decision can change the attributes of grapes and the resulting wine. The second factor is how the wine is fermented and aged. Processing variables such as fermentation temperature, the amount of contact between skins and juice, whether a wine goes through malolactic fermentation, the level and type of oxygen exposure, and the type of container in which the wine is stored all have a dramatic effect on the attributes of the resulting wine. As the ability to control these variables increased with technology, so did the notion of what constituted "quality" wine. Napa wineries were early adopters of science and technology to improve their wines, but they also discovered that "quality" was a moving target that was defined in the marketplace both by other producers and consumer expectations.

It is a truism that fine wine cannot be made from mediocre grapes. Maynard Amerine and Albert Winkler's pioneering work, "Composition and quality of must and wines of California grapes," published in 1944, identified which varieties would be best for a given climatic region. Wineries focusing on quality table wines thus knew which varieties they should use. Their problem was that available plant material was often diseased or from low-yielding clones, making such plantings uneconomic.[3] In the late 1940s and early 1950s, Dr. Harold Olmo, the Department of Viticulture and Enology's grape breeder, traveled throughout the state and to Europe to acquire improved selections of varieties. In 1952, Olmo, in conjunction with his colleagues, Drs. Curtis Alley, William Hewitt, and Austin Goheen, and in cooperation with the California wine industry, established the California Grape Certification Association, a program designed to eliminate viruses from Olmo's selections by subjecting them to prolonged heat exposure. This program ultimately grew into the present Foundation Plant Services, still located at UC Davis (Alley and Golino, 2000; Walker, 2000). The resulting virus-free selections, when grafted to selected rootstocks, resulted in higher-yielding vines with definite varietal character, thus providing both higher wine quality and improved production economics.

Ultimately, the entire California industry benefited from the UC Davis work on variety improvement, but the Napa Valley had invested early in its relationship with the University of California and enjoyed an advantage of proximity. In 1903 the USDA had established a twenty-acre experimental vineyard in Oakville, adjacent to the ToKalon Vineyard. Research work had ceased at the USDA vineyard with the advent of Prohibition and had remained idle following repeal. Members of the Napa Valley Vintners, an association of Napa Valley winery owners, petitioned Congress to deed the land to the University of California for viticultural research. By 1947, the Vintners had grown tired of waiting for government action and, led by John Daniel Jr. of Inglenook, purchased a twenty-acre vineyard site south of the Oakville Grade road and donated it to the university. Seven years later, in 1954, the USDA Vineyard was made available to the university through an act of Congress. Together the "South Vineyard" and the "Federal Vineyard" comprise forty acres and are collectively referred to as the Department of Viticulture and Enology's Oakville Experimental Vineyard (Wolpert, 2000). Much of Olmo's clonal selection work on Chardonnay was done at the Oakville Station (Kliewer 2012), and Mike Martini, a third-generation Napa Valley winemaker and UC Davis graduate, commented that his father, Louis P. Martini, a 1942 graduate of UC Berkeley, where he had studied winemaking, worked closely with Olmo on variety selections at the Martini vineyard in the Carneros region (Martini, 2012). Napa growers could visit the station, compare selections of the same variety, and, in the early days, acquire bud wood for their own vineyards. Similarly, they could view rootstock trials to compare the effect that different rootstocks had on scion productivity. The presence of a UC station in the heart of the Napa Valley must have encouraged interaction between UC Davis faculty and Napa growers, although the effect can't be quantified. Zach Berkowitz, who received his master's in viticulture from UC Davis and who for many years was director of vineyard operations for Domain Chandon, recalls taking visitors to the station to view vineyard trials in the 1980s and 1990s (Berkowitz, 2012), and Andrew Hoxsey, whose family has grown grapes in the Oakville area since the 1880s, loaned his vineyard workers to the station when it needed viticultural labor. Hoxsey found the relation with the Oakville station to be mutually advantageous. As he put it, "It was a wonderful two-way street. Our crews tried to understand the experiment and always learned something from the trials. There were two plants of most varieties that were available for bud wood, and our Semillon is from the station" (Hoxsey, 2012).

Although these early efforts at quality improvement are now either forgotten or taken for granted by current winemakers and grape growers, the improvements in varietal selection and elimination of plant viruses increased both grape yield and quality. Today Chardonnay and Cabernet Sauvignon are the most widely planted white and red varieties in both Napa and California, but in the 1950s both varieties were rarities. The relative unimportance of varietal grapes is reflected in the lack of information provided in the annual reports of the Napa Agricultural Commissioner prior to 1966. In that year, in response to "the many inquiries," Napa County's Agricultural Commissioner, Albert Delfino, included a listing of Napa's grape acreage by variety in his annual report. In 1966 Napa's vineyards totaled 7,242 bearing acres of red varieties, with Petite Sirah leading the list at 1,650 acres, followed by Zinfandel at 892 acres and Gamay at 819 acres. Cabernet Sauvignon, which forty-five years later in 2010 would account for over 40 percent of Napa's vineyard acreage with over 18,000 bearing acres, was fourth among the red varieties at 682 acres. In 1966, 4,139 acres of Napa's vineyards were devoted to white varieties. French Colombard was the most widely planted white variety at 620 acres, followed by Sauvignon Vert at 453 acres, and such varieties as Burger, Golden Chasselas, and Sauvignon Blanc at just under 300 acres each. A scant 139 acres were planted with Chardonnay, which in 2010, with 6,729 bearing acres, represented over 65 percent of Napa's white variety vineyards (Napa Department of Agriculture, Weights and Measures, 1966 and 2010). Napa's present success is predicated on high-quality Cabernet and Chardonnay, and both became more commercially viable following the Olmo selections and virus eradication.


FIGURE 7.2. Thousands of gallons of dessert and table wine sold in the United States in various years.
SOURCE: Lapsley 1996 and other years.

Grapes are the feedstock for wine. In the 1950s professors in enology at UC Davis helped the industry eliminate spoilage and develop a new style of white wine that set the stage for the wine boom of the second half of the 1960s. Quality can be increased both by the addition of positive attributes and the subtraction of negative attributes, and Davis faculty attacked from both directions. Since the repeal of Prohibition, fortified wines had dominated in sales, averaging over two-thirds of U.S. sales by volume (Figure 7.2). These wines were made microbiologically stable by the addition of distilled spirits, and their flavors were the result of controlled oxidation rather than of the grape varieties used in their production. The production of varietal table wines, where the dominant sensory qualities came from the grapes themselves, required a system of production that both emphasized varietal attributes and eliminated characteristics from microbiological spoilage or oxidation. Spoilage was reduced by the use of easily sanitized materials, such as stainless steel, by the measured use of sulfur dioxide, by the use of pure yeast cultures, and later by the introduction of malolactic cultures to conduct the malolactic fermentation, which converts the malic acid in grapes into lactic acid. Varietal characteristics of white grapes were enhanced by cold fermentations through the use of mechanical refrigeration and the resulting varietal aromas were maintained by using inert gas during storage in stainless steel or glass-lined tanks to eliminate oxidation. The marketability of these wines was further enhanced by the use of sterile filtration and bottling, which allowed the wines to be finished with a slight sweetness without risking refermentation in the bottle. Individually, each technology added a bit to the quality equation. Taken in aggregate, these technological breakthroughs allowed the production of a new type of white wine, one that was aromatic of the grape variety (Lapsley, 1996).

The Napa Valley was fertile ground for the processes advocated by the university. Louis P. Martini had studied at UC Berkeley, and Peter Mondavi, the brother of Robert Mondavi, had taken short courses at UC Berkeley following his graduation from Stanford. At Berkeley they were both introduced to the effects of cold fermentation on white wines. On their return from World War II, both were eager to apply their knowledge. In this they were joined by other Napa winemakers. In 1947, Andre Tchelistcheff, the French-trained winemaker at Beaulieu, started an analytical laboratory in St. Helena and organized the Napa Valley Technical Group, a group of Napa winemakers focused on sharing technical information learned from their own experiments (Sullivan, 2008; Lapsley, 1996). The Napa Tech group, which still continues, provided a forum to exchange ideas and applied techniques and certainly was a part of Napa's early adoption of technical information. Ideas that once would have been considered "trade secrets" were openly shared, as winemakers and owners realized that everyone benefited from the enhanced regional reputation associated with higher-quality wines. Clearly, ideas spread and were adopted. By 1949, the California wine industry's trade magazine, *Wines and Vines*, commented that cold fermentation "was almost universal among the leading wineries of the Napa Valley" (Lapsley, 1996: 163), and Napa producers began capturing the majority of awards at the California State Fair.

Peter Mondavi Jr. characterized this early period as "taming the Wild West." In describing his father and other Napa winemakers, he commented that "everyone was learning and self-taught. Europe had generations of tradition, but we were just beginning. We needed an institution like Davis to aggregate information." (P. Mondavi, 2012). The academic side of winemaking was further strengthened in 1950, when the American Society of Enologists was formed, linking Davis faculty with industry members such as Louis P. Martini, who served as president of the society in 1956. Throughout the 1950s and 1960s, Davis faculty interacted regularly with Napa winemakers, sometimes speaking on technical topics at the Napa Tech Group meetings or working on applied technical problems such as malolactic fermentation. Mike Martini remembers that faculty always attended the annual tasting that his father held with the local grape growers, and Dr. Vernon Singleton, who joined the department in 1958, recalled that the faculty sometimes "caught hell" from the larger wineries in the San Joaquin valley for spending so much time in the Napa Valley (Martini, 2012; Singleton, 2012). By the early 1960s, then, winemaking was becoming a science-based profession, the quality Napa producers were investing in education and technology, and a new type of white wine had emerged: one based on varietal characteristics enhanced through processing. All that was missing were consumers.

## "There's Gold in Them Thar Grapes": The Wine Boom of the 1970s

Sometime in the late 1960s, the world changed for California and Napa producers: American consumers began to consume table wines in increasing quantities. Per capita consumption of table wine doubled in ten years, from 1.2 gallons per adult in 1971 to 2.4 gallons in 1980. Why Americans became interested in wine is unclear, although some part of the explanation is generational and demographic. The first of the baby boomers, that cohort born after the end of WW II, started coming of legal drinking age in 1967, and they adopted wine as an alcoholic beverage at a higher rate than had their parents. For the next eighteen years, approximately 4.5 million baby boomers reached legal drinking age each year, steadily increasing the population base of potential consumers. Total volume consumed is the product of population and per capita rate, and both were rising in the decade of the 1970s. Between 1971 and 1980, total volume of table wine produced in California more than doubled, growing from 109 million gallons in 1971 to 248 million gallons in 1980 (Lapsley, 1996). The wine boom was a sufficient cultural phenomenon that, in its November 27, 1972, edition, *Time* magazine featured Ernest and Julio Gallo on its cover, with an accompanying article entitled "There's Gold in Them Thar Grapes" (Lapsley, 1996).

Increased wine production demanded new vineyards. Approximately 200,000 acres of new vineyards were planted throughout California during the 1970s, more than doubling the 130,000 acres of bearing wine grape acreage that existed at the start of the decade (Garoyan, 1975). Napa vineyards experienced a similar trend, as bearing acres increased from 12,254 in 1970 to 22,456 in 1979, an 83 percent increase (Napa Department of Agriculture, 1970 and 1979). However, this expansion does not tell the entire story. Not only were new vineyards set out, but older vineyards were removed and replaced with what the Aldo Delfino, the Napa agricultural commissioner, described in 1975 as "new, higher quality varietals" (Napa Department of Agriculture, 1975). The trend had begun early. In 1966, the first year that Delfino listed vineyard acreage by variety, he wrote that "grape acreage . . . continues to show a steady climb" and noted that Napa had 11,381 bearing acres of vineyard and 357 acres that were nonbearing. Four years later, in his letter of transmittal in the 1970 annual report, Delfino commented that "wine grape acreage continues to increase substantially in Napa County, as prune orchards are removed and replanted to grapes . . . In 1970, 1200 acres of prunes were removed." He then reported that "1090 acres of vineyards were planted in 1970, 500 of these are new plantings. The remaining 590 acres were replantings of old existing vineyards" (Napa Department of Agriculture, 1966 and 1970). Five years later the trend of replanting old vineyards had accelerated, and Delfino wrote, "Approximately 600 acres of grapes were pulled preparatory to replanting to new, higher yielding, varietals." In that year Napa had 15,725 acres of bearing vineyards but 8,528 acres of nonbearing acres (Napa Department of Agriculture, 1975). Napa growers had seen the future and knew that it would be in grapes. By 1980, wine grapes accounted for 74 percent of all of Napa County's agricultural value, a percentage that would grow to 95 percent by 1990 (Figure 7.3).

The increase in vineyard acreage was paralleled by an increase in the number of Napa wineries. Prior to the emerging interest in table wine, the wine business had been in slow decline in both Napa and the state as a whole, reaching a nadir in Napa in 1960 when Napa counted just twenty-three wineries and California claimed 256. In the decade of the 1960s, the state total continued to decline to 240 wineries by 1970, but Napa increased to thirty-two in 1970. New wineries of the 1960s included Heitz Cellars (1961), started by Joseph Heitz, who had received an MS in enology from Davis; Schramsberg Vineyards (1965); Robert Mondavi Winery (1966); Freemark Abbey and Chappellet (1967); Spring Mountain and Sterling Vineyards (1968); and Chateau Montelena (1969). By the early 1970s, the wine boom was obvious, and during that decade Napa more than tripled its number of wineries. Memorable startups of the early 1970s included Mt. Veeder, Caymus, Diamond Creek, Stag's Leap Wine Cellars (1972), Silver Oak, Joseph Phelps, Cakebread Cellars, and Domaine Chan-

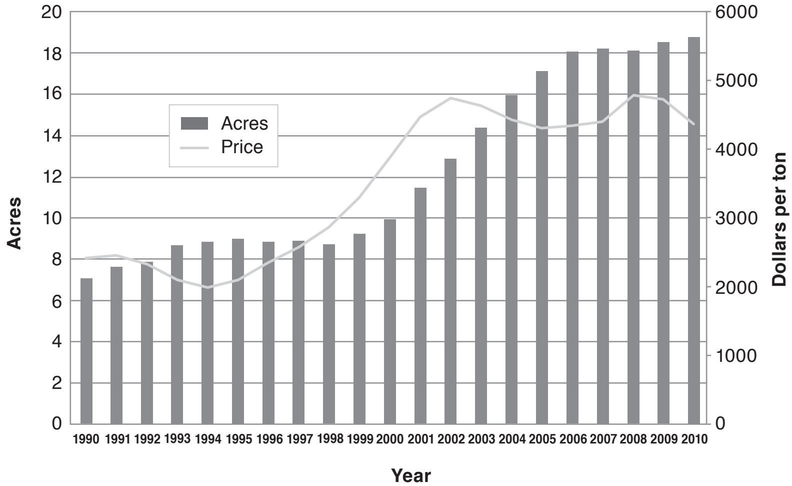


FIGURE 7.3. Napa Cabernet acres and price.

SOURCE: California Department of Food and Agriculture *Grape Crush Report* and *Grape Acreage Report*, 1990–2010.

don (1973), the first foreign-owned investment in the Napa Valley (Sullivan, 2008: 444–445).

For the most part, the new Napa wineries were small operations compared to those in other parts of California. Some of the owners, such as Robert Mondavi of the Robert Mondavi Winery, Charles Carpy of Freemark Abbey, and Justin Meyer of Silver Oak, had long experience with wine production and sales. Some had experience in grape growing. "Chuck" Wagner of Caymus came from a family of Napa grape growers. But most were newcomers who joined the wine business after achieving success and wealth in other businesses. A look at the background of some of the owners of the wineries started in the 1960s and early 1970s reveals a diverse group of individuals. Jack Davies was a Harvard MBA who had worked in the aerospace industry in California prior to buying Schramsberg and producing sparkling wine. Donn Chappellett of Chappellet had founded and run a major food service corporation in Southern California until deciding that growing grapes and making wine in the Napa Valley was a better way to raise a family. James L. Barrett was a successful attorney in Los Angeles before becoming a partner in Chateau Montelena. Michael Robbins, a Southern California real estate investor, had been an investor in the Mayacamas winery and entered the industry as a winery owner when he purchased Spring Mountain vineyards, a historic estate above St. Helena. Peter Newton and Michael Stone were partners in Sterling Paper, a San Francisco paper products company, invested in Napa valley vineyards, and then founded Sterling Vineyards. Al Brounstein owned a pharmaceutical wholesaling firm in Southern California before purchasing vineyard land south of Calistoga and starting Diamond Creek. Warren Winiarski had studied and taught political theory at the University of Chicago until moving to California to become a winemaker. He worked at Souverain and the Robert Mondavi winery prior to founding Stag's Leap winery. Jack Cakebread was a semiprofessional photographer who was working at the family auto repair business in Oakland before purchasing his vineyard in Rutherford and founding Cakebread Cellars. Although different in background and wine experience, all shared a passion for wine and a desire to make the best wine possible (Sullivan, 2008).

Individual motives are difficult to determine, but groups can share traits. Dick Maher, former CEO of Beringer and Christian Brothers who has worked in the Napa Valley for forty years, believes that for most owners of small wineries in the Napa Valley the business is "a hobby, but a competitive hobby" (Maher, 2012). Maher described owners who had excelled in other businesses before starting wineries and who were determined to succeed in creating high-quality wine, with income being a secondary goal. His description aligns with a 1997 study by Morton and Podolny of 184 California winery owners, which divides owners into "profit maximizers" and "utility maximizers" (Morton and Podolny, 2002). Profit maximizers resemble traditional business owners, while utility maximizers are in the winery business primarily for nonmonetary reasons. Thus Morton and Podolny report that

> . . . 78% of owners would be "somewhat" or "very" unlikely to sell their winery if they could get a higher return in the stock market. Almost 40% of respondents would lose over $10,000 to improve the quality of their wines. Although almost all respondents aim to cover costs and earn some profit, less than half have a specific target rate of return in mind. (Morton and Polodny, 2002).

It would seem that most of the individuals starting wineries in the Napa Valley in the late 1960s and early 1970s were "utility maximizers" and, although not immune to financial constraints, were driven to excel in quality.

It was "utility maximizers" such as these who led to Napa's stunning breakthrough in 1976 when Napa wines "beat" the French at an unofficial tasting in Paris. Steven Spurrier, an English owner of a wine shop in Paris,

TABLE 7.1. The Paris tasting.

| *White* | *Red* |
|---|---|
| 1. Chateau Montelena,* 1973 | 1. Stag's Leap Wine Cellars,* 1973 |
| 2. Domaine Roulot, 1973 | 2. Chateau Mouton Rothschild, 1970 |
| 3. Chalone Vineyard, 1974 | 3. Chateau Haut-Brion, 1970 |
| 4. Spring Mountain Vineyards,* 1973 | 4. Chateau Montrose, 1970 |
| 5. Joseph Druhin, 1973 | 5. Ridge Vineyards, 1971 |
| 6. Freemark Abbey,* 1972 | 6. Chateau Leoville-Las-Cases, 1971 |
| 7. Ramonet-Prudhon, 1973 | 7. Mayacamas Vineyards,* 1971 |
| 8. Domaine Leflaive, 1972 | 8. Clos du Val,* 1972 |
| 9. Veedercrest Vineyards,* 1972 | 9. Heitz Cellars,* 1970 |
| 10. David Bruce, 1973 | 10. Freemark Abbey,* 1969 |

* Indicates a Napa wine.

used the occasion of America's bicentennial to advertise his business by staging a blind tasting between California and French wines of the same type or variety. Spurrier had heard that California wines were improving in quality, and he procured six California Chardonnays and six California Cabernet Sauvignons, putting them up against France's best wines and using respected French judges. To the chagrin of the French, the California wines came out on top. To the joy of Napa producers, the top wines were both from Napa: a 1973 Chateau Montelena Chardonnay, which was just the fourth vintage from that winery, and a 1973 Stag's Leap Wine Cellars Cabernet, from a winery that had opened its doors only a year before. The results, based on Spurrier's rankings (which Ashenfelter and Quandt, n.d., suggest are broadly sound statistically), are listed in Table 7.1, with Napa wines marked by an asterisk. It is worth noting that of the six California Chardonnays, four were from the Napa Valley, as were five of the six California Cabernets. Clearly, even in the mid-1970s, Napa was perceived as the quality leader in California.

Spurred by the "Judgment of Paris" and increasing consumer interest in wine, the California wine boom continued. By 1980, California totaled 508 wineries, ninety-five of which were in Napa County. The decade of the 1980s saw accelerating growth, with the state's total growing to 807 wineries and Napa's to 176 by 1990 (*Wines and Vines*, 1980 and 1990). Thus, in a twenty-year period from 1970 to 1990, the number of wineries in Napa increased fivefold. This expansion created a need both for trained enologists and viticulturists to operate the new facilities and for continuing education for owners and would-be winemakers, who needed to gain an understanding of the winemaking process and business.

Dan Duckhorn, who had come to the Napa Valley in 1968 with an MBA from UC Berkeley, worked for various wine companies for several years, and then started Duckhorn in 1976, commented that when he moved to the Napa Valley there were only "two sources of information: UC Davis and Gallo" (Duckhorn, 2012). Of the two, UC Davis was by far the most approachable, and winery owners traveled both to Davis in search of talent and information and to the Oakville Station or the Farm Advisor office in Napa for more local advice.

The first choice for an investor without technical knowledge who wished to start a winery and vineyard was to hire an experienced winemaker or viticulturist—but in the early days of California's wine boom, such individuals were rare. The second choice was to hire a recent graduate from UC Davis, and Davis graduated twenty to forty students each year, fewer in the early years. Some, like Craig Williams (BS, UCD 1976), who became the winemaker at Joseph Phelps in 1983, were undergraduates who had decided on fermentation science as a major. Others, such as Cathy Corison (MS, UCD 1975), discovered wine after graduation. Armed with a BS in biology from Pomona College, Corison came to Davis to pursue an MS degree and became the winemaker for Chappellet Vineyards, where she worked for ten years before starting her own winery in 1987. Others were scions of already established wineries. Michael Martini, the third generation of winemakers in his family, graduated from Davis with a BS in fermentation science in 1977. Down the road from the Martini winery, Bruce Cakebread, whose parents Jack and Dolores Cakebread had established Cakebread Cellars in 1973, graduated from Davis with a BS in fermentation science a year after Martini in 1978.

A third group was comprised of individuals who had gravitated to wine or grape growing, showed strong promise, and were encouraged by their employers to pursue a degree at Davis while continuing to work for the firm. This was the case for Zach Berkowitz, who had graduated from UCLA with a degree in sociology and arrived in the Napa valley in 1973. He began working for Domaine Chandon in 1974 while completing an AA degree in viticulture at the Napa Valley Community College. Berkowitz became the Domaine Chandon vineyard manager in 1976, and his French employers offered to pay for him to complete a second undergraduate degree, encouraging him to go to Davis because, as Berkowitz put it, "Davis was the gold standard." Berkowitz received his BS in plant science with an emphasis in viticulture in 1980 (Berkowitz, 2012). Similarly, Bill Dyer had graduated with an undergraduate degree in philosophy from UCSC, became intrigued with wine, and had been hired by Ric Forman (MS, UCD 1967) to be cellar foreman at Sterling in 1977. Following Forman's departure to establish Newton Vineyards, Sterling encouraged and funded Dyer's master's in fermentation science at Davis. Following the completion of his degree in 1985 he became winemaker, and four years later he was named vice president for wine production (Dyer and Dyer, 2012). Although individual stories varied, a degree from UC Davis was a guarantee to a prospective employer that the individual was both well trained and capable of solving problems.

Not everyone interested in commercial winemaking and grape production had sympathetic employers or the time to commit to a formal education at UC Davis. For these individuals, UC Davis University Extension, the self-supporting continuing education arm of the Davis campus, offered short courses in wine and grape production. The Department of Viticulture and Enology had throughout the 1950s and 1960s offered occasional "short courses" in wine production and wine analysis intended as updates for industry members. Beginning in 1978, the Department of Viticulture and Enology partnered with UC Davis University Extension to offer courses aimed both for commercial producers and for individuals seeking to enter the wine industry. In the seven years between 1978 and 1985, approximately twenty to thirty courses were offered each year, totaling over 5,500 enrollments for the period (unpublished information derived from UC Davis enrollment records).

Some courses, such as Economics of Small Wineries, Fundamentals of Table Winemaking, Wine Microbiology, Wine Filtration, or Wine Grape Production, were multiday programs lasting three to five days. Others, such as Grape Disease Management, Legal Aspects of Establishing a Winery, Spectrophotometers for Wine Analysis, Introduction to Wine Chemistry, Trends in Winery Equipment, or Cooperage Care and Construction, were one-day classes. Most were repeated and updated each year. For individuals interested in investing in a winery but not necessarily in being the actual winemaker, the introductory technical courses provided an overview of winemaking processes while the Economics of Small Wineries course, which was offered four times, reviewed costs of production and sales as well as capital requirements for equipment and inventory. For winemakers and vineyard owners, courses such as Wine Filtration, Canopy Management, or Phenolics in Wine and Grapes provided an update on most recent research coupled with application. Enrollments came from throughout California and beyond, but an analysis of enrollments shows that participation from Napa wineries and vineyards was especially high, coming to over 18 percent of all enrollments during the period, approximately equal to Napa's share of California wineries in 1980.

Napa winemakers and growers not interested in making the one-hour drive to Davis could also turn for advice closer to home by visiting their viticulture farm advisor or dropping by the Oakville Experiment Station. The University of California's Cooperative Extension service (UCCE) traces back to the federal Smith-Lever Act of 1914, which provided funding to hire university-trained individuals distributed geographically, often referred to as county farm advisors, to extend science-based information to farmers. Farm advisors were allocated based on the crops that were grown in a particular county, and in 1952 Jim Lider became Napa's first farm advisor for viticulture. Lider had grown up on a farm in Esparto, north of Davis, and graduated with a BS from Davis. He was later to complete a master's in viticulture from Davis in 1965. His brother, Lloyd Lider, received a PhD in plant sciences from Davis and became a professor of viticulture in the department in 1953, so Jim Lider was well connected to the department. As a farm advisor, Lider worked individually with Napa's vineyard owners and managers to decrease costs and to increase production through the planting of virus-free variety selections. In 1961 he advised Nathan Fay to plant Cabernet Sauvignon on Fay's property in the Stag's Leap district, which had been considered too cool for Cabernet. The advice had historic repercussions. Warren Winiarski purchased the property adjacent to the Fay Vineyard and planted Cabernet because of the quality of the Cabernet from the Fay vineyard (Napa Valley Wine Library Association, 2011a,b). Without Lider's advice, Winiarski might never have produced the Cabernet that took first place in Paris. And, in another connection to the University of California, the Cabernet budwood came from Martha's Vineyard in Oakville, which had in turn accessed budwood from the Oakville Station (Napa Valley Wine Library Association, 2008).

The Oakville Station, comprised of two twenty-acre blocks, is in the middle of the valley and was easily accessible to Napa grape growers. For many years, the station was run by Keith Bowers, who had received his BS from Davis in viticulture following WW II and who became the manager of the Oakville Station in 1949 (*St. Helena Star*, 2008). Bowers helped Tom and Martha May plant Cabernet Sauvignon in the thirty-five-acre parcel adjacent to the South Vineyard, a vineyard now known as "Martha's Vineyard" and made famous by Joe Heitz in 1966 (Napa Wine Library Association, 2008). It was the 1970 vintage from Martha's Vineyard that was tasted in the Paris judging. Bowers completed his master's in viticulture in 1965 and became the Napa County farm advisor in viticulture in 1972, when Lider retired, a position he maintained until his own retirement in 1987. As a farm advisor, Bowers's main interaction was with individuals, but in the mid-1970s he also helped create a viticultural version of the Napa Valley Technical Group. Phil Freese (PhD, UCD 1973), who was directing CalPlan, a major vineyard management firm in the Napa Valley and who in 1982 became the Robert Mondavi Winery's vice president of winegrowing, remembers a lunchtime meeting at Bowers's office in Napa with Bob Steinhauer of Beringer and Will Nord of Domaine Chandon. By the end of lunch they had made a collective decision that a once-a-month lunch meeting for vineyard managers would help disseminate UC research as well as pass on information derived from local vineyards. They decided that the meetings would last only an hour and would be intended for individuals with at least a BS in plant science or viticulture (Freese, 2012). Bowers organized the meetings, bringing researchers from UC Davis to meet with Napa Vineyard managers. Thus began the Napa Valley Vineyard Technical Group, which still meets once a month on Mondays. In 1979 the vineyard manager from Joseph Phelps, Ed Weber, joined the group, fresh from his BS from Davis. Ed would complete his MS in viticulture from Davis in 1982 and become the new Napa farm advisor in 1988, following Bowers's retirement.

During the 1980s, the vineyard technical group had a great deal to discuss. In 1980, Dr. Mark Kliewer, a professor of viticulture at Davis, had begun a major vineyard trial at the Oakville Station. The five-acre Cabernet Sauvignon trial was designed to explore the major management factors effecting canopy growth. It included two trellising systems to determine the effect of light penetration, three different row spacings to determine the effect of vine density in vineyards, and five pruning levels to determine the effect of crop load. It was a major experiment that continued until Kliewer's retirement in 1994. One of the major findings was the importance of filtered light on grape clusters. Most growers at the time were using a trellis system often referred to as "the California sprawl" that buried the grape clusters in foliage. The trial revealed that moderate light exposure improved cluster color, led to earlier ripening, lowered potassium levels in the berries (and thus in the resulting wine), lowered the grape pH, reduced vegetative aromas in Cabernet, improved the tannin levels, and largely eliminated Botrytis rot. As Kliewer put it, the trial "opened some eyes" (Kliewer, 2012). It also opened some winery checkbooks.

In 1982, shortly after joining the Robert Mondavi Winery, Freese organized the North Coast Viticultural Research Group (NCVRG), for the purpose of funding university research on the production of premium grapes for wine or, as it is now referred to, "winegrowing." The member wineries included Christian Brothers, Sterling, Beringer, Domaine Chandon, Joseph Phelps, and Robert Mondavi from Napa and Jordan and Simi from neighboring Sonoma County.[4] The wineries agreed to contribute funds each year to support university researchers, to make their vineyards available as research sites, and to produce experimental wines from the trials. The research would ultimately be published in scientific journals, but the member wineries followed the research as it was conducted and gained site-specific information about their own vineyards. The focus of the research was on how viticultural factors affected grape attributes and the resulting wine.

The NCVRG funded several Davis faculty members. Kliewer's research became focused on light penetration and canopy management. With his graduate student, Nick Dookozlian, Kliewer examined the effect of such viticultural practices as shoot thinning, pruning levels, leaf removal, and timing of hedging, all with the purpose of understanding how changes to the canopy microclimate effected the grapes and wine. Dookozlian completed his PhD in 1990 and joined the department as an extension viticulturist (Dookozlian, 2009).

The NCVRG also funded Dr. Mark Matthews's experiments on water management in vineyards, which ultimately showed that grape composition and quality were enhanced by limiting the amount of water to the vines, a practice which is now referred to as "deficit irrigation." The experiments on canopy management and irrigation helped Napa viticulturists transition from being grape growers to becoming winegrowers by showing how human decisions affected the qualities of the resulting wine. The research also resulted in practical tools such as pressure bombs that could be used in the vineyard to measure leaf water potential and point quadrants that quantified levels of light penetration into the canopy. Ultimately the research created metrics for predicting wine quality in the vineyard.

The decade of the 1980s was a period of continued growth for the Napa Valley. In January of 1981, the Napa Valley's importance as a grape growing region was recognized when it became the first California region to become an American Viticultural Area, a designation created by the federal government in response to the growing economic importance of grape location in the marketing of wine. During the decade, eighty-one new wineries were established, bringing the total to 176, which represented over 20 percent of California's 807 wineries (*Wines and Vines*, 1990). University research was unraveling the interaction between grape environment and resulting wine quality. University Extension and Cooperative Extension were disseminating the research findings and teaching how tools could be used and metrics applied in the vineyard. The enologists and viticulturists, many of whom had been educated at Davis, were taking the new ideas and tools and putting them into practice in Napa's vineyards and wineries. No one suspected that lurking in the soil was an insect that would ultimately cause the replanting of most of Napa's vineyards within a decade.

## "RESET": THE AXR1 CRISIS AND THE TRIUMPH OF CABERNET SAUVIGNON

In 1983, a Napa grower noticed that some of his grapevines were declining. The cause wasn't obvious. After examining the roots, university viticulturists were both surprised and dismayed to discover that phylloxera was feeding on the rootstock, a variety called "AxR1" (Phylloxera Task Force, 1988). AxR1 had been recommended by the university and had been widely planted throughout California during the vineyard boom of the 1970s. It was estimated that approximately 70 percent of Napa's vineyards were planted with AxR1. What had happened, and how had the university failed California growers?

Phylloxera is an insect native to the eastern United States, where it feeds on the roots of native grape species, which, through coevolution with phylloxera, have developed varying degrees of resistance to the insect. During the nineteenth century, amateur botanists in Europe moved exotic plant species to Europe, including American grape vines. Attached to the roots of some of the specimens was phylloxera, which promptly spread to the European wine grape, *Vitis vinifera*, in the 1860s in France. Not having any natural resistance to phylloxera, *vinifera* was killed by the insect. French scientists responded to the crisis in a variety of ways, but the solution that was finally chosen was to graft a *vinifera* scion to a resistant rootstock, thus allowing wine production to continue. Some American species of *Vitis* are more resistant than others; some don't root or graft to vinifera easily; and others, when grafted, impart varying degrees of vigor and yield in the scion. For this reason, French, and later American, scientists conducted breeding and rootstock trials to discover the best rootstocks for general use.

One way to improve a non-*vinifera* species' ability to graft with *vinifera* is to create an interspecies hybrid. In 1879, the French viticulturist, Victor Ganzin, crossed the *vinifera* variety, Aramon, with a selection of the American species, *Vitis rupesteris*. Nine seedlings were produced, numbered one through nine, and three were for a time recommended by French nurseries, although ultimately all were rejected by French viticulturists because of insufficient resistance to phylloxera. The experience in California was somewhat different. AxR1 was included in a 1904 USDA rootstock trial and again in a UC trial begun in 1911. In 1929, UC Professor Harry Jacob began a massive rootstock trial conducted in seventeen locations throughout California. In none of the trials or locations did AxR1 succumb to phylloxera. Jacob's trial was completed more than twenty years later by Professor Lloyd Lider, who published his finding in the 1958 *Hilgardia* article "Phylloxera-resistant grape rootstocks for the coastal valleys of California." Based on trunk growth and grape yield, Lider concluded that AxR1 was the best general choice for coastal vineyards. In several of the locations, phylloxera was observed on AxR1 roots, but the plant itself was fine, indicating some degree of resistance. In his article, Lider alluded to the failure of AxR1 in France and described AxR1's resistance only as "moderate." He concluded that AxR1 should be used in vineyards with deep soils and irrigation, where environmental stress was low (Wolpert et al., 1994).

In retrospect, any rootstock with *vinifera* genetics is suspect, but the fact that AxR1 was part *vinifera* made the rootstock easy to propagate and graft. It quickly became the favorite rootstock for nurseries, which were called on to produce tens of millions of grafted plants during the planting boom of the 1970s. In describing the benefits of AxR1, Freese commented that "it was hard to kill, grew well, gave good yields and made life simple. With AxR we didn't have to focus on viticulture" (Freese, 2012). Tim Mondavi reinforced the economic advantage of AxR1, succinctly stating, "The grape industry liked the yield" (T. Mondavi, 2012). But in 1983, AxR1's advantages paled against its failure to withstand phylloxera. UC Davis entomologist Jeffrey Granett examined the phylloxera discovered in Napa and by 1985 had determined that a new biotype of phylloxera, which he named "type B," had evolved to exploit the AxR1 rootstocks. It was estimated that 40,000 acres of vineyards in Napa and Sonoma were planted to AxR1 and would eventually need to be replaced (Wolpert et al., 1994). Replanting in Napa began in the late 1980s and was generally concluded by the mid-1990s.

In 1991, Mike Fisher's estimate of the cost solely for Napa's replanting put the amount at $250 million (Fisher, 1991). Over a decade later, wine writer Rod Smith said that most estimates put the total cost, including lost sales, at "around $3 billion" (Smith, 2007). More recently, in 2011 *The Economist* magazine, in an article titled "Gripe Grapes," placed the "damage" at $6 billion (*Economist*, 2011). In economic terms the "loss" associated with this event would need to assess replanting costs that occurred sooner than would have been necessary without phylloxera as well as including costs associated with lower yields during the first years of production. However, against these costs one must balance higher grape prices due to reduced output and include the value of cultural improvements that were adopted earlier than would have been the case had replanting not been necessary. A true accounting, which has not been done, would measure the grower's net returns rather than gross costs. Whatever the true cost, the replanting was expensive. Although the result of a mutation, many growers viewed the phylloxera epidemic as a human-made disaster that had been caused by the UC Davis recommendation of the rootstock.

Yet, today, most winery owners and viticulturists point to the AxR1 rootstock failure as the key event that catapulted Napa wine into the same heights as Burgundy and Bordeaux. Dan Duckhorn referred to AxR1 as "a blessing in disguise" (Duckhorn, 2012), and the French international consultant Michel Rolland stated, "If phylloxera hadn't happened, Napa Valley couldn't be where it is today" (Franson, 2008). Although an economic disaster at the time, the phylloxera epidemic forced a major replanting of the Napa Valley much sooner than would have normally occurred. Most vineyards have an economic life of thirty years, and so vineyards established in the 1970s would not normally have been replaced until the first decade of the twenty-first century. The forced replanting allowed growers and wineries to incorporate the new ideas about canopy management, vine density, and irrigation when they set out their new vineyards. New rootstocks were matched to soil types, and new clonal selections became available (Martini, 2012). Berkowitz (2012) described "the whole valley as a series of experiments" and Tim Mondavi (2012) commented that the "replanting was done with a focus on diversity and geography. It was an epidemic, and we all shared information." Phil Freese (2012) referred to the phylloxera replanting as "a reset, a synchronizing event" that forced Napa growers and wineries to reach beyond California for answers and to broaden their worldview of fine wine. Vineyards replanted to new trellis systems and densities using controlled irrigation of virus-free clonal selections resulted in wines that ripened more fully, allowing for greater fruit and wine intensity.

Replanting also allowed Napa wineries and vineyard owners to focus more on the production of red wine. The wine boom of the 1970s had been predominantly a white wine boom that had caused vineyard owners to plant in-demand white varieties in areas of the valley that were too hot for high-quality white wine production. Cathy Corison (2012), who came to the Napa Valley in 1978, recalls that growers were "trying to grow Cabernet in Carneros and Riesling in Calistoga." Andy Hoxsey (2012) "looked at the crisis as an opportunity." In the 1970s, his family's vineyards, located near Oakville in the heart of the valley, were 75 percent white varieties. Today those same vineyards are planted to Cabernet Sauvignon. (The replanting of the Napa Valley to Cabernet is graphically depicted in Figure 7.3.) Since 1990, starting from a base of just over 7,000 acres, Napa has added almost 12,000 additional acres of Cabernet. Conversely, Chardonnay, which counted almost 8,000 acres in 1990, has declined by 1,000 acres over the same time period (California Department of Food and Agriculture, *Grape Acreage Report*, 1990 and 2010).

The decision to replant to Cabernet was driven by grape prices, which were in turn driven by consumer demand. In 1990, the average prices of Napa Cabernet and Chardonnay were almost equal: Chardonnay averaged $2,267 a ton, 94 percent of the average price of Cabernet. Twenty years later, the average price per ton of Chardonnay had remained essentially static at $2,170 but was now less than 50 percent of the average price per ton of Cabernet, which had risen to $4,731. During the 1990s, America experienced a second wine boom, but this time it was focused on red wine. Between 1990 and 2000, per capita consumption of white wine remained static, but per capita consumption of red wine tripled.[5] The white wine boom of the 1970s had been made possible by winemaking technology that allowed the production of fruity and flavorful white wines. White winemaking processes such as barrel fermentation, the use of malolactic bacteria to induce a buttery flavor to the wine, and lees stirring, which added a rich mouth feel to white wine, imparted flavors separate from the fruit itself. These processes could be used on grapes from any location, thus reducing the importance of place and lowering the price premium that Napa growers normally received.

Unlike Chardonnay, which gains significant flavor from processing choices external to the grape, Cabernet derives most of its flavor from the grape variety, which in turn is influenced not simply by where the grape is grown, but by how the grape is grown. Napa is an excellent location for Cabernet production, and in the decade of the 1980s Napa growers had begun to learn how to maximize the benefits from those grape qualities. The American demand for high-quality red wine that emerged in the 1990s coincided with the need to replant Napa's vineyards. With few exceptions, the most expensive wines throughout the world are red wines. High wine prices create high grape prices, which in turn encourage growers to spend more dollars on viticultural practices to enhance quality. In the short term, phylloxera was an economic disaster for growers and wineries, but it cleared the way for a dramatic improvement in Napa red wine. As Michel Rolland put it: "It is the best sad story. Now Napa has some of the best vineyards in the world" (Franson, 2008).

From 1990 to the present, the Napa Valley has focused on red wine production, primarily Cabernet Sauvignon. In 1990, in the middle of Napa's replanting, Cabernet Sauvignon sales totaled just over $52 million, approximately 25 percent of Napa's total value of $210 million. Twenty years later, in 2010, Cabernet Sauvignon sales totaled over $243 million, representing 55 percent of the value of Napa's total grape revenue, which in turn accounted for over 98 percent of Napa's farm income (California Department of Food and Agriculture and Napa Agricultural Commissioner, various years). (See Figure 7.4.) In 2010, Napa counted 733 wineries, an increase of 400 percent in twenty years. If phylloxera was a disaster for some individual firms, Rolland was correct in describing it as "the best sad story" for the Napa Valley as a whole.

## "WE ARE BOTH HOSTS": NAPA AND UC DAVIS

John Williams, a transplanted New Yorker who received his MS from Davis in 1977, founded Frog's Leap Winery in 1981. Williams is known for taking a holistic view and, when asked to characterize the relationship between UC Davis and the Napa Valley wine industry, replied: "It is a symbiotic relationship, we are both hosts" (Williams, 2012). Davis supplies ideas and well-educated graduates to the industry, and the industry

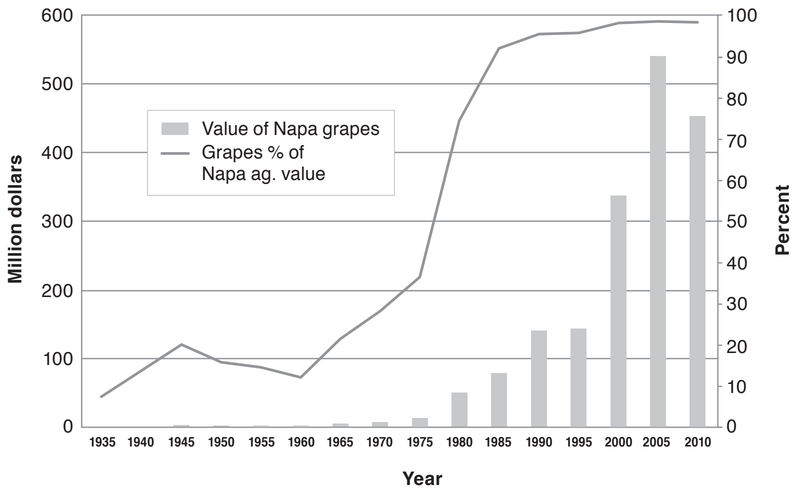


FIGURE 7.4. Value of Napa grapes and grape value as a percentage of total Napa agricultural value.

SOURCE: Napa Department of Agriculture, Weights and Measures. 1940–2010. *Agricultural Crop Report*. Napa.

raises questions and sometimes funds the research necessary to answer the questions. For Williams, grape growing and winemaking cannot be static. Rather, they incorporate constant improvements that come from critical thinking. It is the role of the university not just to train people to become competent technicians—and, after all, when stripped of its romance, winemaking is really a branch of food processing—but to be critical thinkers. As Williams (2012) asked, somewhat rhetorically, "Can you think of a great winemaking region that doesn't have a university associated with it?"

The importance of Davis to the Napa Valley is reflected in the high percentage of Davis graduates working in the Napa Valley as winemakers. A 2012 unpublished review of 395 Napa winery websites conducted by the authors showed 231 wineries listing their winemaker by name and education. Of the 231, 180 claimed their winemaker had attended Davis.[6] The next greatest numbers were fourteen from the University of Bordeaux and nine from CSU Fresno. Clearly, UC Davis graduates dominate wine production in the Napa Valley and have for at least a generation. As Bill Dyer put it, "Today, both the Old Guard and the Young Guard are from Davis" (Dyer and Dyer, 2012). These trained and creative graduates are one of the most important elements in the interaction between Davis and the Napa Valley. Although the number of wineries has grown dramatically in California, reaching well over 3,000 by 2010, the number of department faculty has remained static for two decades. It is impossible for faculty to visit every winery in California, and Davis research, although presented at academic meetings and industry short courses, is often disseminated through personal connections with former students and by recent graduates as they enter the wine industry.

An example of the interaction between industry, faculty, and students can be seen in the development and dissemination of an assay for tannin that is now known as the Adams-Harbertson assay, named after Dr. Doug Adams of the department and his former graduate student, and now professor, Dr. James Harbertson. In 1995 Adams, a biochemist who studies grape ripening, met with the North Coast Viticultural Research Group over lunch to discuss possible research topics. Toward the end of the meeting, one of the group commented that what viticulturists needed was an easy, quick and accurate assay for tannins. Tannins are compounds that bind with proteins, such as human saliva, thus imparting astringency to wines. They are part of a broader group of compounds, phenols, which also include anthocyanins, the pigments responsible for color in wines. Adams (2012) recalled an article that had used a ninety-six-well plate that bound tannin to the plastic, allowing rapid determination of tannin.[7] By chance, a UC Davis undergraduate with a joint major in biochemistry and art, Jim Harbertson, had recently taken VEN003, the introductory class on wine and winemaking, and was interested in working on a project on grapes. Adams had Harbertson attempt to use the procedure described in the article to measure grape tannin. It didn't work, but it was the start of an eight-year collaboration between the two that culminated in 2003 when Harbertson submitted his doctoral dissertation, "The Measurement of Tannins and Polymeric Pigments During Grape Ripening and Winemaking."

During their eight years of research together, Adams and Harbertson developed an assay that measured total phenols, anthocyanins (pigments), tannin, and polymeric pigments (anthocyanins bound to tannins). For grape growers, such measurements allow objective comparisons between vineyards and varieties. For winemakers, the assay can be used to know how much tannin and color is available for extraction into wine, as well as determining when enough has been extracted for a given wine style. Most of the graduate and undergraduate students in the department were aware of the research, if only because Adams tested commercial wine samples and then asked students to taste the samples to correlate measurements with perceived astringency. As students entered the industry, some wanted to run the assay in an industrial setting in order to make production decisions. They contacted Adams, who made the assay available on his lab website, and in the mid-2000s Adams participated in panels with commercial winemakers to discuss how the assay is run and how commercial winemakers use it to make decisions about particular lots of grapes and wines. One particular example was Theresa Heredia, a doctoral student agricultural chemistry at Davis, who was a teaching assistant with Harbertson and thus familiar with his research. When Heredia was hired as a research chemist at Joseph Phelps in 2001, she began using the Adams-Harbertson assay at Phelps. Other Napa wineries such as Rubicon and Stag's Leap were also early adopters of the assay (personal communication with James Harbertson). Dr. Steve Price, a biochemist who taught viticulture at Oregon State University and who is now a private consultant, credits the Adams-Harbertson assay for "greatly broadening the range of people using tannin as a basis for making enological decisions," although he finds the assay complex (personal communication with Steve Price).

The assay is an involved wet-chemical procedure, and operator precision is important in producing reliable results. Dr. Roger Boulton of the department has been working for a number of years to measure wine and grape phenolics through the use of a spectrophotometer to measure absorbance at visible and ultraviolet (UV) wavelengths. The advantages of such a procedure are speed and the elimination of wet chemicals. The problem is to correlate absorbance at specific frequencies with precise measurements of phenolic groups. Boulton's graduate student, Kirsten Skogerson, used the Adams-Harbertson assay to measure classes of phenolic compounds in commercial wines and correlated these with absorbance in the wines, ultimately creating a predictive model that worked well for predicting tannin, total phenols, and anthocyanin. Skogerson completed her MS in 2006 and published her findings in the *American Journal of Enology and Viticulture* in 2007. Recently, Scott McLeod (2012), the former winemaker at Rubicon, and his partner Giovanni Colantuoni have commercialized the technology with the development of their company, Wine X Ray. They create unique databases for wineries by analyzing wine and grape samples from a winery and correlating these with visible spectrum and UV readings for the same wines. This then allows wineries to take their own spectrophotometer readings, which are then sent to Wine X Ray, who compares them to past samples and generates predictive values for the wines and grape samples.

The business is in its infancy but promises to allow wineries to receive phenolic values for their wines rapidly enough to make real-time winemaking and viticultural decisions without performing their own wet chemistry and becoming expert in the assay. Ultimately this will be another tool for the winemaker to use in crafting wine.

The Adams-Harbertson assay is just one example of a measurement tool that was developed or adapted by UC faculty as a research instrument and then transitioned into the wine industry and used by grape growers and winemakers. Other examples include pressure bombs, which determine vine water status, and point quadrants, which help measure canopy density. All have allowed grape growers and winemakers to improve their wines. Dawnine Dyer (Dyer and Dyer, 2012), who for many years was the winemaker for Domaine Chandon, believes that "one of the biggest improvements" in the industry during her professional career, "is understanding grape phenolics and ripeness." That understanding has helped to improve wine quality throughout California, but it has particularly benefited Napa red wine producers, which compete at the top end of world production. For this reason, Napa wineries have been earlier adopters of analytical tools to improve grape and wine quality. Just as high grape prices allow grape growers to invest more in viticultural practices to assure high quality, so too do high wine prices allow wineries to spend money and effort in improving their wine.

Napa produces expensive wines that compete at the highest prices in the world market. To remain competitive, Napa winery owners have invested not only in land and technology but also in a creative and scientifically trained workforce. Michaela Rodeno, the founding CEO of St. Supery for almost thirty years, commented that "information has always been in short supply in this business" and that in her opinion UC Davis's most important contribution to the Napa Valley wine industry had been "educating a cadre of top flight winemakers" (Rodeno, 2012). Tim Mondavi (2012) believes that "the most important attribute that Davis brought to the California industry was instilling curiosity in its students." The faculty taught him critical thinking and a scientific way to solve enological and viticultural problems that were specific to a vineyard or winery. As T. Mondavi (2012) put it, "We did trials and we learned." For Bill Dyer (Dyer and Dyer, 2012), the education he received at Davis "provided a safety net" that allowed him to try native yeast fermentations at Sterling. He speculated that a well-educated winemaker "can take more risks because you know where the edge is." Bruce Cakebread (2012), who employs several Davis graduates at his winery, spoke of "the deep understanding of science" exhibited by UC Davis graduates and their ability to incorporate new ideas. Bob Steinhauer (2012), who has worked in the Napa Valley since 1971 and who was vice president for viticulture for Beringer for most of his time in the valley, certainly thinks that the Davis faculty research was extremely important, but ultimately concludes that "students are the biggest attribute that Davis has." John Williams (2012) concurs with his fellow winemakers, saying that Davis's major accomplishment in the Napa Valley has been that it "educated and fostered three generations of winemakers. It taught them how to communicate and advance knowledge."

Tip O'Neill is credited with the observation that "all politics is local." Perhaps the same is true for research, which ultimately must be translated into action in a given setting if it is to be of use. The Napa Valley is an excellent location to grow grapes, and wine has come to dominate the Napa economy as nowhere else in California. But wine quality is ultimately defined by the consumer, and environment alone is not sufficient to create wine that consistently sells at the highest prices. Environment is certainly one of three key factors to Napa's success, but the other factors are human. Creative, wealthy, and dedicated owners, who are willing to spend what it takes to pursue excellence and to promote the resulting wine to the world, comprise the second key factor in Napa's success. Without the financial resources and a desire and commitment to compete at the highest level on the part of its winery owners, Napa could not have succeeded as it has.

The third key factor must be the influence of UC Davis, through its research, its outreach, and its teaching. Davis research, from early clonal selections through vineyard irrigation and canopy trials to assays to assess grape attributes such as tannin and color, has provided new ways to measure, understand, and improve grape and wine quality. University outreach, through the Cooperative Extension viticultural farm advisor, the Oakville Experiment Station, and University Extension, has provided individual and group education for Napa grape growers and wineries, helping them to incorporate new ideas and to understand the need for improved quality. Education for undergraduate and graduate students has not only documented best practices but, more importantly, has supplied Napa, California, and the world with individuals capable of conducting their own investigations to advance quality wherever they are located.

In these three aspects of its mission, UC Davis and the Department of Viticulture and Enology have played a crucial role in the success of the Napa Valley and in the defining of wine quality in the United States and the world. Robert Mondavi was thus correct in his statement that "UC Davis has been a true partner in building the international reputation of the California wine industry."

## NOTES

All of the individuals interviewed graciously gave of their time. They average at least thirty years of personal experience with Napa grape growing and winemaking and in total amount to over 600 years of experience. Their insights were invaluable for writing this chapter.

1. The book to which Mondavi refers was written by Professor W. V. Cruess in 1934. Later editions were titled *The Technology of Winemaking* and were coauthored by Cruess, Amerine, Berg, Kunkee, Ough, Singleton, and Webb.

2. In this chapter, "table wine" refers to wine with an alcohol concentration of under 14 percent, as opposed to "fortified" wines that have had their alcohol concentration increased by the addition of distillates. "Table wine" is not a quality assessment, as it is in Europe. "Dry" refers to the absence of sugar in the resulting wine, as all of the grape sugars are converted to alcohol by the yeast during alcoholic fermentation.

3. Over time, genes in grape varieties mutate, leading to differences such as leaf shape, berry color, disease resistance, ripening date, or cluster size and shape. Because grapes are heterozygous and do not breed true to type from seed, they are propagated by cuttings to maintain their varietal characteristics. Selections of vines of the same variety but with different characteristics are referred to as "clones."

4. All of the representatives were university trained, most with degrees from Davis. Rollin Wilkenson (Christian Brothers) had a BS from UCD in viticulture, where he had worked with Olmo. Tucker Catlin (Sterling) had a BS in plant science with an emphasis on viticulture from UCD. Bob Steinhauer (Beringer) had an MS from Fresno State University. Will Nord (Domaine Chandon) had a UCD master's in vocational agriculture with a focus on horticulture. Ed Weber (Joseph Phelps) had both a BS and an MS from Davis in viticulture. Phil Freese (Robert Mondavi) had a PhD in biochemistry from Davis. Zelma Long (Simi) had a BS from Oregon State University and studied but did not complete a masters in enology at UC Davis. Rob Davis (Jordan) had a BS in fermentation science from UCD.

5. It is beyond the scope of this chapter to address why red wine consumption tripled. Some observers have suggested that aging baby boomers began consuming red wine to lower risk of heart attacks and strokes, which had been highlighted by Morley Shafer report on "The French Paradox" on the program *60 Minutes* in 1991. The decade from 1991 to 2001 was also a period of economic prosperity.

6. We have used "attended" because it is not clear that all have matriculated.

7. A well plate is a flat plate with minidepressions, or wells, that act as miniature test tubes and allow rapid processing of multiple samples at one time.

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