

# Chardonnay History and Selections at FPS

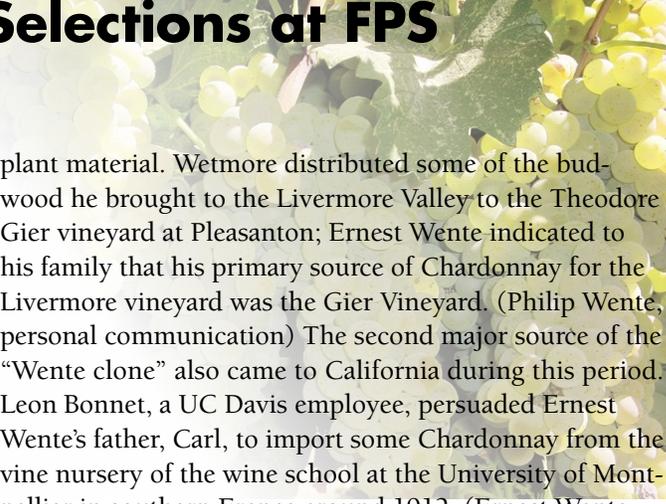
by Nancy L. Sweet, Foundation Plant Services, UC Davis

THE NOBLE CHARDONNAY GRAPE OF BURGUNDY and Champagne has long been a member of the wine aristocracy. The classic white wine grape, whose name means “a place of thistles” in Latin, traces its heritage to the Middle Ages and a small village of the same name in the Maçon region of France. (Olmo 1971) Chardonnay has maintained its place at the top of the white wine hierarchy for centuries, within the precise French wine-making tradition. The esteem with which it has been held in France is reflected by a comment from Alexandre Dumas, the French novelist, who was quoted as saying that one high quality French Chardonnay named Montrachet should be sipped only while kneeling and with head bowed. (Taber 2005)

Chardonnay found its way to the New World in the late 19<sup>th</sup> century when California was awakening to the possibilities of its own wine industry. Uncertainty relative to the precise time of its arrival was caused by a combination of lack of knowledge about the variety and mislabelling of newly-introduced Chardonnay grapes. Notwithstanding morphological and physiological differences, the Chardonnay variety has long been confused with the true Pinot blanc variety and, on occasion, with Melon. (Galet 1998; Christensen et al. 2003). Additionally, the identity confusion in California was aggravated by the use of alternate spellings and erroneous names for the variety, including Chardenai, Chardonay, Pinot Chardonnay, Pinot blanc Chardonnay, and White Pinot. (Olmo 1971)

Some sources indicate that Chardonnay was present in California by the 1880s. In 1882, Charles Wetmore, the President of the California State Viticultural Commission, imported Chardonnay budwood from Meursault in Burgundy and distributed it in the Livermore Valley, the site of Wetmore’s own winery, La Cresta Blanca. (Asher 1990) Chardonnay appeared in the catalogue of the Barren Hills Nurseries of Felix Gillet in Nevada City in 1888-89. University of California (UC) records from 1896 show that university researchers E.W. Hilgard and F.T. Bioletti had tested Chardonnay grapes (under the name “Pinot blanc Chardonnay”) and Pinot blanc grapes sent to them from around the state. (Amerine 1990) Additional documents show that Chardonnay was grown in the University or substation vineyards in the late 19<sup>th</sup> century. (Olmo 1971)

Many of the important current sources of Chardonnay budwood at Foundation Plant Services (FPS) have their genesis in imports by California growers around the turn of the 20<sup>th</sup> century. The Wetmore budwood provided an integral component of the well-known “Wente clone”



plant material. Wetmore distributed some of the budwood he brought to the Livermore Valley to the Theodore Gier vineyard at Pleasanton; Ernest Wente indicated to his family that his primary source of Chardonnay for the Livermore vineyard was the Gier Vineyard. (Philip Wente, personal communication) The second major source of the “Wente clone” also came to California during this period. Leon Bonnet, a UC Davis employee, persuaded Ernest Wente’s father, Carl, to import some Chardonnay from the vine nursery of the wine school at the University of Montpellier in southern France around 1912. (Ernest Wente, oral history 1969; Asher 1990) The third major source of California Chardonnay was imported from Burgundy by Paul Masson for his La Cresta Vineyard in the Santa Cruz Mountains in 1896. (Asher 1990)

Notwithstanding the importations by California growers, UC researchers did not recommend that growers plant Chardonnay for wine making in the early 20<sup>th</sup> century. (Amerine 1990) Much of the state’s existing Chardonnay was destroyed during Prohibition because the delicate thin-skinned fruit could not withstand shipment to the East Coast for home winemakers. (Olmo 1971) The result was that Chardonnay had a very limited presence in California vineyards at the end of Prohibition in 1933. The only Chardonnay acreage with commercial potential in California at that time were the Wente and Masson vineyards.

Around the time of WWII, the University of California did recommend Chardonnay as a desirable variety for producing quality table wine in the cooler regions of the state, namely, Winkler climate regions I and II (e.g. the Central or North Coast regions of California) and tentatively III (e.g. the Livermore Valley). (Amerine 1990) One of the strengths of Chardonnay is its malleability—it adapts and thrives in diverse climates and in a wide range of soil types. Vine yields vary considerably (2 to 8 tons per acre) by climatic region, clonal variation and viticultural practices. (Christensen et al. 2003)

Chardonnay thrives in cool districts such as Winkler Region 1, where it produces lighter, crisper, more neutral wines with higher acidity which are frequently used in sparkling wines. However, Chardonnay vines leaf out and bud early and are susceptible to damage from early spring frosts, which can be a disadvantage in the cooler areas. (Olmo 1971) Chardonnay also excels in warmer areas where the fruit ripens more fully in the longer growing season and produces more highly-flavored wines than in the cooler zones.

Despite the UC recommendation, there was still a hesitancy to produce much Chardonnay wine in the 1950s. The variety demonstrated low fruit yields and frequently suffered from viruses in California. Moreover, the wines produced were usually mislabeled as Pinot chardonnay. (Amerine 1990) By 1960 it was estimated that only about 150 acres of Chardonnay existed in California, mainly in Alameda and Napa counties. (Christensen et al. 2003) An indication that Chardonnay remained a minor player is the fact that, prior to 1968, Chardonnay acreage was reported by the California Department of Food and Agriculture (CDFA) as part of the “Miscellaneous” category in its statistical reports. (Amerine 1990)

The grape and wine industry showed an increased willingness to experiment with the Chardonnay variety in the 1960s. Davis experts, led by University of California viticulturalist Dr. Harold P. Olmo and USDA-ARS plant pathologist Dr. Austin Goheen, selected and tested promising California clonal material and subjected it to heat treatment to eliminate the viruses that impeded yields. The result was higher-yielding, virus-tested clonal material that produced effectively in various climate zones, including the warmer interior valleys in California. An increase in Chardonnay acreage in this period was also attributed to improved production efficiency and improved wine quality. The reported Chardonnay acreage in California in 1968 was 986 bearing acres. By the mid-1970s, the acreage had steadily increased to a total of more than 7000 bearing and nonbearing acres, including all five California climate regions. (Amerine 1990)

California’s very young Chardonnay industry was about to be an unwitting participant in a controversy which would publicly challenge the esteemed French wine makers. In 1976, the unassuming siblings of the ancient French Chardonnay grape caused a shock wave in the wine world when a California Chardonnay, Chateau Montelena 1973, bested some of France’s most prestigious whites in a low key blind tasting in a Paris hotel. New York Times reporter George M. Taber chronicled the event in his book, “*Judgment of Paris: California vs. France and the Historic 1976 Paris Tasting that Revolutionized Wine.*” Leading French wine experts awarded California Chardonnays four of the six top places in that tasting. All nine judges gave their highest scores for white wine to a California Chardonnay, either Chateau Montelena or Chalone. (Asher 2002)

Following the Judgment of Paris in 1976, California Chardonnay plantings increased exponentially. Chardonnay acreage quadrupled from 2700 to 11,000+ acres between 1970 and 1980, and then quadrupled again to 45,000 acres by 1988 to overtake France’s total Chardonnay acreage. (Wolpert et al. 1994; Robinson 2006) The familiar

“California style” Chardonnay wine—ripe, buttery, and oakey—was developed with riper grapes, acid-lowering malolactic fermentation and aging in oak barrels. The mania continued with a huge increase in planting of Chardonnay grapes in California, peaking in the mid-1990s. By the turn of the 21<sup>st</sup> century, Chardonnay was the state’s most widely planted wine grape variety, with total acreage exceeding 100,000 acres. (Christensen et al. 2003)

The overproduction of Chardonnay and widespread success of the California-style wine made it fashionable for some wine drinkers to begin to complain about “flabby” or “fat” Chardonnays and to “boycott” (Anything But Chardonnay) the variety as passé. Chardonnay producers responded to the criticisms with the increased popularity of a crisp new style involving fermentation in steel barrels and high acidity, offered as an alternative to the full, rich, oaky version. The discussion continues today among wine makers and wine drinkers as to which style shows the grape to its best advantage. Chardonnay continues to successfully survive its critics.

In 1991, DNA fingerprinting performed on Chardonnay revealed that one of the noble grape’s ancestors was a viticultural “commoner.” Microsatellite analysis showed that the parents of Chardonnay were the Pinot grape and nearly-extinct Gouais blanc, both of which were widespread in northeast France in the Middle Ages. (Bowers et al. 1999b) The Pinot parental line offers a possible explanation for the longtime misidentification of Chardonnay as the “white Pinot.” It is theorized that Gouais blanc vines were given in the 3rd century to what was at the time Gaul by Probus, a Roman Emperor from Dalmatia. Gouais blanc is the same variety as ‘Heunisch weiss’ which was previously grown in Eastern Europe as ‘Belina Drobna.’ The lack of respect the French had for the Gouais grape is illustrated by the fact that the name was “derived from an old French adjective ‘gou’—a term of derision.” The Gouais grape was grown by peasants on land not considered acceptable for a Pinot or another noble grape. Gouais blanc is no longer planted in France. Famous siblings from the same fertile Pinot x Gouais blanc cross include Aligoté, Melon, and Gamay noir. (Bowers et al. 1999b)

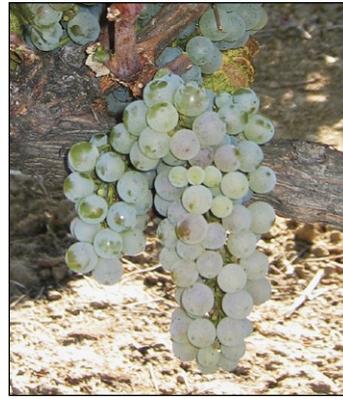
The noble Chardonnay has persisted atop the white wine hierarchy amid the challenges and surprises. The variety is successful in multiple climates, soils, and wine-making styles because of its adaptability. Chardonnay continues to have the greatest acreage of the wine grapes planted in California. Statistics reported by the Wine Institute (California) and WineBusiness.com for 2006 wine sales show that Chardonnay is still the top-selling variety in the United States. It remains the most important premium white table wine variety in the world.

## CLONAL DEVELOPMENT IN CALIFORNIA

FPS maintains a large collection of Chardonnay selections, most of which are available to the public. The FPS selections embody two main styles of the Chardonnay grape. Traditional Chardonnay grape clusters are small to medium size and cylindrical. The berries are small and round and have thin skins. Chardonnay often suffers from *millerandage*, whereby clusters contain both normal- and small-sized berries, known as “hens and chicks” or “pumpkins and peas.” (Christensen et al. 2003; Robinson 2006) The second style of Chardonnay differs from the traditional form in flavor profile. Clones known as Chardonnay *musqué* are an aromatic subvariety of Chardonnay that has a slight muscat flavor, probably caused by an accumulation of monoterpenes during fruit maturation. (Reynolds et al. 2007) There is a third Chardonnay form, a rare pink mutant called Chardonnay rosé, which is not available in the FPS collection.

California Chardonnay plant material in the post-WWII period, when the wine industry was initially developing the grape as a wine varietal, had two primary sources—the Wenté vineyard in Livermore and the Paul Masson Vineyard in the Santa Cruz Mountains. As noted previously, there were two separate French sources of Chardonnay grapes for the vines in the Wenté vineyard. Distinct clonal lines emerged from the Chardonnay developed from these sources. Distinctions between clones are manifested by subtle morphological and biochemical differences. Researchers have proved that clonal diversity within ancient winegrape cultivars such as Chardonnay has a genetic basis accounted for “by the differential accumulation of somatic mutations in different somatic lineages.” (Riaz et al. 2002) Chardonnay is very adaptable to many climates and soils; clonal variation results over time when plant material from the same source is dispersed to various climate and topographical regions throughout the state. Several researchers have observed differences in Chardonnay clonal selections, manifested in yield, vigor, fruit intensity and composition, and flavor profiles. (Christensen et al. 2003; Bettiga 2003)

Formal grape clonal selection programs in the United States have not received the financial support that has allowed European programs to progress. Despite this limitation, Dr. Olmo was able to make a great contribution to Chardonnay clonal selection in the late 1950s. He had observed that the Chardonnay plant material available in California at that time produced low yields with shot berries and suffered from viruses. Dr. Olmo attributed those qualities to the lack of interest in the variety by the California grape and wine industry. (Olmo, undated) He conducted Chardonnay trials at Louis Martini’s Carneros



A few undersized berries interspersed among normal-sized grapes, also known as 'hens and chicks' can be seen on this cluster of Chardonnay FPS 72. This condition can have varying amounts of small berries in proportion to the number of larger ones.  
photo by Jarve Manning

vineyard and at the University’s Oakville vineyard in the 1950s and 1960s and identified several selections for virus elimination treatment in Dr. Austin Goheen’s program at Foundation Plant Services. These eventually became the most widely planted Chardonnay selections in California. The Olmo Chardonnay program increased the yield of Chardonnay vines substantially, raising the average yield from ½ ton per acre in the 1950s to over 5 tons per acre. (Christensen et al. 2003)

The term “Wenté clone” is pervasive in the Chardonnay story because many growers, as well as Dr. Olmo, obtained budwood either directly or indirectly from the Wenté vineyard in Livermore. Philip Wenté stated in an e-mail: “The primary interest in obtaining wood from [the Wenté] vineyard was that it had been continually selected by Ernest Wenté for vines showing desirable traits and replicated in different new vineyard selections over 30 to 40 years. That wood was non-existent in the few other Chardonnay vineyards in the state at the time. CDFA records indicate around 230 acres of Chardonnay in California in 1960, so there were most likely only a few growers ... our records showed Wenté with about 70 acres at that time.” The term “Wenté clone” can be confusing in that it has been used both for an older selection with small clusters that sometimes contain a high percent of shot berries and for the more productive selections at FPS that can be traced back to the Wenté Vineyard. (Christensen et al. 2003) The “old Wenté” clone is notable for its frequent “hens and chicks” berry morphology and clonal variation in flavor and aroma. (Asher 1990) The heat-treated UC selections developed from the Wenté grapes do not exhibit the *millenderage* (“hens and chicks”) tendency. Some of the clonal variants derived from the Wenté material are known by names such as Robert Young, Stony Hill, and Curtis clone(s). Chardonnay-*musqué* style Wenté variants include Spring Mountain, See’s, Sterling and Rued.

A fact of historical interest is that FPS at one time possessed plant material which originated directly from the

Wente Livermore Vineyard. **Chardonnay FPS 03** came to FPS around 1963 with a source designation of “Wente 6 v18” and “Wente 10 v27,” and was not heat treated. This selection was planted in the Foundation Vineyard in 1964 and first appeared on the Registered list that year as Chardonnay FPS 03. In 1965, the name was changed to **Chardonnay FPS 03A**. It disappeared from the Registered list in 1966 but was still distributed by FPS as late as 1968. Austin Goheen wrote in 1986: “Chardonnay 3A was a selection from a commercial planting in Livermore Valley. It was abandoned in 1968 because it did not set normal fruit [it had shot berries].” (Goheen paper 1986)

Two of the first to propagate vineyards directly from the Wente’s vineyard were Fred and Eleanor McCrea, who harvested wood from the Livermore vineyard in 1948 for their new vineyard at Stony Hill above Napa Valley (Asher 1990; Letter from Virginia Cole 1992) With the permission of Herman Wente, they took cuttings “at random” from a great number of Chardonnay vines throughout the Wente vineyard. The McCreas then planted the wood at their Stony Hill vineyard in St. Helena. They were early pioneers in Chardonnay planting in California at a time when there were less than 200 acres of Chardonnay planted. Later, others such as Louis Martini and Hanzell took Wente clone wood from the McCreas’ Stony Hill vineyard.

Louis Martini, Jr. took wood, which he referred to as the “Wente clone,” from Stony Hill Chardonnay vines for planting at the Martini family Stanly Lane Vineyard in Carneros in 1951 or 1952. (Olmo undated) The name “Stanly Lane” is derived from the historic ranch of Judge John Stanly. In 1942, Martini purchased 200 acres of the Stanly Ranch and years later began clonal experimentation with several varieties including Chardonnay. (Olmo undated; Winter 2007) Martini selected 30 individual vines at Stony Hill and budded 20 grafts from each of the 30 vines onto St. George rootstock. He later allowed UC Davis to use these 600 vines for trials. (Olmo undated)

Dr. Olmo began clonal selection of Chardonnay for the UC Davis collection in the early 1950s. His goals were to improve yield, eliminate the shot berry quality of many Chardonnays, and select against vines that appeared to be infected with virus. After measuring vine yields and making small wine lots in glass from the vines in the Martini vineyard for a number of years, Dr. Olmo made selections for the University’s clonal propagation program from the Stanly Lane vines beginning in 1955. The wood for what was later to become **Chardonnay FPS selections 04–08** and **14** (the “Martini selections”) was taken from the Stanly Lane vineyard in Carneros. (Olmo undated)

Dr. Olmo then advanced three of the Martini selections (Olmo #68, #70, and #72) to field and wine trials at the

UC Oakville Experimental Vineyard from 1960 to 1966. He compared them to one clone obtained in Meursault, France (former FPS Chardonnay 02 and Olmo number 812) and two clones from Alsace, France (Olmo numbers 430 and 439). In the Oakville experiment, the Martini selections yielded as much as 5 tons, which was 2 to 3 tons per acre more than the French selections, which were abandoned long ago by FPS. (Wolpert et al. 1994; Olmo undated; Goheen paper 1986)

In 1964, the initial group of Martini selections, which were then identified by numbers given to them by Dr. Olmo (for example, Olmo #66 (FPS 04), #68 (FPS 06 and 08) and #69 (FPS 05)), were taken to FPS for heat treatment to rid them of any virus. The issue of whether or not heat treatment eliminated virus was not well-settled at that time. USDA-ARS Plant Pathologist Dr. Austin Goheen explained in a 1985 letter: “Chardonnay became one of the first cultivars to test out the possibility of thermotherapy. We took the best appearing vines and heat treated them. From the explants that we obtained we indexed several lines. One line, which indexed disease-free and which was easily recognizable as a good Chardonnay, was registered in the California Clean Stock program.” (Goheen 1985)

Vines produced from single buds that were heat-treated were given unique selection numbers even if the buds were taken from the same original parent plant. For example, FPS selections 06 and 08 were both propagated from the same source vine, designated Olmo #68, at the Stanly Lane property. Each of these so-called Martini selections was heat-treated for a different period of time. The heat-treated Martini Chardonnay selections released to the public through the California Registration & Certification (R&C) Program for Grapevines are also sometimes referred to as “heat treated Wente clones.”

## CALIFORNIA AND WASHINGTON CLONES

**Chardonnay FPS 04** (formerly Olmo #66) and **FPS 05** (formerly Olmo #69) were two of the selections brought to FPS by Dr. Olmo from the Martini Carneros vineyards. Both selections underwent heat treatment for 90 days and were first registered in the California R&C Program for Grapevines in 1969. Although the selection did not test positive for virus, Chardonnay 04 underwent microshoot tip tissue culture treatment in 2009 to qualify for planting in the new Russell Ranch foundation vineyard. The 2010 Protocol requires that all vines in that foundation undergo that microshoot tip tissue culture treatment. The new version of Chardonnay 04 could be available as early as spring, 2013, if it successfully passes the testing.

In the 1960s (prior to the time FPS selections 04 and 05 were released as Registered plant material) Curtis Alley, a UC Davis viticulture specialist, combined the two selections



Clusters of Chardonnay FPS 04 hang in the foundation vineyard at FPS. One of the FPS selections constituting 'clone 108,' it was widely planted and included in most field trials. Photo by Bev Ferguson

into what he called “clone 108”—most likely due to the fact that despite originating from separate mother vines, the two selections had undergone heat treatment for the same length of time. “Clone 108” was also variously called the “Davis clone” or the “Wente clone,” and was distributed throughout the 1960s when it was used to plant most of Washington State’s and half of Napa’s Chardonnay. (Asher 1990; Goheen letter 1986)

Wente Brothers was one of the early recipients of the heat-treated derivative of the old Wente clone for their new property in Monterey County. Philip Wente confirms that Wente Vineyards records show that in 1963 Wente received wood from FPS from location “G9 v5-6,” which at the time was known as clone 108 but was later identified as FPS 04. Wente planted clone 108 in new increase block 36 at Arroyo Seco. Clone 108 was separated into FPS selections 04 and 05 in 1969 due to the fact that the selections had originated with different vine sources.

**Chardonnay FPS 06 and 08** (both formerly Olmo #68) were taken from the same vine at the Martini vineyards. FPS 06 and FPS 08 received individual FPS selection numbers as they underwent heat treatment for different lengths of time; 164-2 days and 114-3 days, respectively. FPS 06 yielded over four tons per acre in the field trials conducted by Dr. Olmo in the late 1950s, making it the highest yielding selection of the Stanly Lane vines. Chardonnay FPS 06 and FPS 08 first appeared on the FPS Registered list in 1973.

**Chardonnay FPS 09, 10, 11, 12 and 13** were all propagated from FPS 08 in the late 1960s. FPS 09 and 10 underwent heat treatment for 102 days; FPS 11 and FPS 12 for 116 days; and FPS 13 for 144 days. They all first appeared on the FPS Registered list in 1973.

**Chardonnay FPS 14** (formerly Olmo #65) came to FPS from the Martini Stanly Lane vineyard via UC Davis’ West Armstrong tract in the late 1960s. It was subjected to heat treatment for 111 days and first appeared on the Registered list in 1974.

Although widely planted on the West Coast, the “Davis clones” have been criticized by some winemakers who feel that a healthy yield capacity is at odds with production of high quality wine. Others believe that the Davis plant material such as “clone 108” is desirable if a crop is controlled by holding yields to a certain maximum amount such as three or four tons per acre). (Asher, 1990) The following statement appeared in the journal *Wine & Spirits* in April 1994:

“The Chardonnay clones selected and developed for the industry in the 1970s by Dr. Harold Olmo and his colleagues at UC Davis, particularly the dependable, high-yield clone #108, accomplished the goal of making Chardonnay commercially viable in California. By raising the basic level of quality, Dr. Olmo’s work conferred the freedom to pursue a more elusive aesthetic ideal. For years, that pursuit was conducted furtively with suitcase clones smuggled in from France and propagated on the sly, unfortunately with their viral diseases and other problems intact.” (Smith 1994)

In contrast, Bill Knuttel, Chalk Hill winemaker, was quoted in *Trellis Talk* in June 2000 about Chardonnay 04:

“Growers should not forego any of the clones that have been in use, especially FPMS 4 ... [which] is more subject to vintage variation than some other clones, especially because of yield, but with the right site and vintage conditions, it normally produces healthy yields and good wine. Many of the great Chardonnays of 1994 and 1995 had clone 4 as a base.”

The FPS “Martini” selections (Chardonnay FPS 04, 05, 06, 08, 14) and their propagative offspring (Chardonnay FPS 09-13) have undergone several field trials to assess their performance in various California climate zones. FPS 04 and 05 have been the Chardonnay workhorses in the state since they were initially distributed together as “clone 108.” Either FPS 04 or 05 is invariably included in every California study of Chardonnay selections.

UC Davis researchers conducted field trials at Jaeger Vineyards and Beringer Vineyards in the Napa Valley between 1989–1991. The purpose was to evaluate clonal differences among six certified virus-tested FPS selections (Chardonnay FPS 04, 05, 06, 14, 15, 16). Only clones testing free of virus were used to ensure that observed differences were genetic and not due to virus status. Both FPS 04 and 05 had characteristic high yields with large numbers of

heavy clusters and high numbers of moderately heavy berries per cluster. FPS 06 yielded more but lighter clusters, with fewer berries per cluster than FPS 04 and 05. FPS 06 and 15 (discussed below) exhibited the greatest pruning weights at both sites. (Wolpert et al. 1994)

Field performance of the same six FPS Chardonnays plus Chardonnay FPS 09 was assessed in the Salinas Valley in 1994–1996, with similar results to the Napa trials. FPS 06 and 09 originated from the same plant material in the Martini Stanly Lane vineyard (Olmo #68) but underwent heat treatment for different periods of time. (Bettiga 2003)

Chardonnay FPS 04 and 05 again showed the highest yields, attributable to higher cluster weights, large berry size and weights, and higher numbers of berries per cluster. Titratable acidity was highest and pH lowest for selections 04 and 05; the later maturity of these selections had also been observed in prior experiments. This tendency to later maturity has ripening implications for cool climate areas with shorter growing seasons. (Bettiga, 2003)

Pruning weights were highest for selections Chardonnay FPS 06, 09 and 15, which was similar to the Napa trials, and those three selections were in a group with intermediate yields, fewer berries and clusters and lower berry weights than selections FPS 04 and 05. FPS 06 and 09 showed modest yields with a higher number of smaller clusters per vine. However, no significant differences in yield, growth or other experimental parameter were detected for FPS 06 and 09, leading the researchers to conclude that the different heat treatment periods imposed on the two selections from the same source vine did not influence vine performance. (Bettiga 2003)

The heavy clusters driving the high yields exhibited by Chardonnay FPS 04 and 05 in the cool-climate trials could be problematic in the warmer climate regions of California on the theory that large tight clusters could suffer more sour rot than smaller or lighter clusters. Approximately 7% of the state's Chardonnay is grown in the San Joaquin Valley. (Fidelibus et al. 2006)

Researchers in Fresno County evaluated the performance of Chardonnay FPS 04, 06, and 15, along with two Italian clones and one French clone (discussed below) for performance in a warm climate. Data from 2000–2003 revealed a “strikingly significant,” more so than Napa and Salinas, year x clone interaction for yield and yield components for FPS 04 and 15. For three of four years, FPS 04 showed the fewest and heaviest clusters; this was attributed to having more berries per cluster. The researchers rated the Chardonnay FPS 04 fruit as having the most desirable fruit composition of the clones tested, with higher Brix, lower pH and higher titratable acids. The longer growing

season of the warm climate region favors the fruit in this late-maturing selection. However, FPS 04 and two others (FPS 20 and 37) had the highest incidence of susceptibility to sour rot. That trait is a major disadvantage for FPS 04 when grown in the warm climate area of the California Central Valley. The researchers ultimately recommended that growers in that region consider Chardonnay FPS 15 rather than Chardonnay FPS 04 due to its low bunch rot potential. (Fidelibus et al. 2006)

**Chardonnay FPS 15** was sent to UC Davis in 1969 by “the father of Washington Wine,” Dr. Walter Clore, of the Irrigated Agriculture Research and Extension Station (IARES) in Prosser, Washington. Dr. Walter Clore was a horticulturalist associated with Washington State University's Prosser Experiment Station for 40 years. He presided over field and wine trials for 250 grape varieties, including Chardonnay, and was primarily responsible for convincing Washington growers that premium wines could be made from *vinifera* grapes grown in Eastern Washington. Clore planted variety blocks at Prosser beginning in the late 1930s using *vinifera* material that he and his mentor, Sunnyside farmer and winery owner W.B. Bridgman, imported from Europe and from California growers. (Clore et al. 1976; Irvine et al. 1997)

Chardonnay FPS 15 has been known in the state of Washington as “the Prosser clone.” Other than a location designation “Prosser LR 2v6”, the origin of Chardonnay FPS 15 is not clear. The Clore variety blocks at Prosser were split into “High” and “Low” sections. FPS 15 was from row 2 vine 6 of the Low section variety block. The selection underwent heat treatment at Davis for 173 days and has since tested negative for viruses. Chardonnay FPS 15 was registered in the California R&C Program for Grapevines in 1974 and has been one of the most requested Chardonnay selections in the past five years.

A 1-½ acre variety trial was established at the IAREC vineyard in 1965 using premium wine grapes including Chardonnay; the analysis of the experiment does not report a source for the Chardonnay plants used in the trial but does indicate that the material in the trial was known to be infected with virus. Data on yields and fruit composition were reported for 1967-1970. The Chardonnay in the trial was one of the lowest yielding varieties, with 3.78-5.59 tons per acre, and had loose clusters and an excessive amount of shot berries. It was infected with leafroll virus. Grape maturity and fruit analysis figures for the four-year period of the trials varied from: °Brix 21.3 to 23.1, which was within the range of FPS 15 in Fresno 22.8 and Salinas 23.2; 0.76 to 1.03 percent titratable acid, which was higher than Fresno 0.58 and Salinas 0.65; and pH 3.20 to 3.43, which was lower than Fresno and Salinas 3.70 and

3.61. (Clare et al. 1972) The grape morphology, timing of the Washington IAREC trial, and the fact that the Chardonnay in the trial was virus-infected suggest that this Chardonnay was the clone that eventually became FPS 15.

Chardonnay FPS 15 has been evaluated in numerous California field and wine trials. In addition to the trials mentioned above, UC Cooperative Extension Specialist Larry Bettiga began a second trial in Monterey County in 1995 near the city of Greenfield. Chardonnay FPS 05 and 15 were used as standards to compare with some French and Italian clones. (Bettiga 2002, unpublished) Chardonnay FPS 15 was also included in the Chalk Hill trial at Healdsburg, Sonoma County, begun in 1989. FPS 15 produced relatively low to moderate yields in all the trials.

Yields for the trials in the cooler growing areas were:

County	Vineyard	kg/vine	Researcher(s)
Napa	Jaeger/Beringer	9.3	Wolpert et al. 1994
Sonoma	Chalk Hill	4.94-8.12	Heald and Heald 1999
Monterey	Salinas/Zabala	3.83	Bettiga 2003
Monterey	Salinas/Pacific	6.79	Bettiga 2002

In the Fresno County trial, Chardonnay FPS 15 yielded an average of 19.9 kg/vine for the four-year period, which was the lowest of the six selections tested. FPS 15 experienced erratic fruit yield over the years as indicated by significant year x clone interaction in some of the trials. The lower yields were also attributed to lower cluster weights due to smaller and fewer berries per cluster. A large number of shot berries was reported in all the trials except for Fresno. In summary, although FPS 15 demonstrated high vine vigor in the trials, it produced lower yields due to higher numbers of smaller, loose clusters.

The Fresno and Sonoma/Chalk Hill researchers found FPS 15 to be “sour-rot resistant” and “rot resistant,” respectively. The Fresno researchers found 70-90% fewer clusters with sour rot in FPS 15 than with the other selections tested. The cluster morphology and sour-rot resistance led them to recommend Chardonnay FPS 15 for the warmer growing areas of the Central Valley. (Fidelibus et al. 2006)

Chardonnay FPS 15 has received good marks for fruit composition in some of the trials. The Fresno researchers concluded that FPS 15 had acceptable fruit quality due to fewer soluble solids and high titratable acidity. In trials at Simi in the early 1990s, it was concluded that FPS 15 had a great “intensity” of fruity flavor, which could be excellent for blends. (Letter from Virginia Cole 1992) The Chalk Hill researchers found FPS 15 to be one of the five most preferred clones in the wine tasting category of the trials due to consistently high quality wine produced over the years; FPS 15 was advanced to further trials at Chalk

Hill. (Heald and Heald 1999; Trellis Talk 2000) The researchers concluded: “[FPS 15] is projected to be ideal for cool climates and Reserve Chardonnay programs.” (Heald and Heald 1999)

One of the other popular FPS Chardonnay selections is **Chardonnay FPS 17**, from the Robert Young Vineyard in Alexander Valley. Its original source vines have often been referred to as “the Robert Young clone” which was planted with budwood brought from the Wente vineyard in Livermore in the 1960s. (Asher 1990) FPS 17, a proprietary selection held for Robert Young Vineyards, underwent heat treatment upon its arrival in Davis in 1982 and first appeared on the FPS Registered list in 1987.

FPS 17 was included in the Chalk Hill trials in Sonoma County. The 1996 harvest showed that FPS 17 had a moderate yield amounting to 6.5 tons per acre—higher yielding and with larger clusters than FPS 15. Chardonnay FPS 17 had many small shot berries and showed some rot resistance. The researchers concluded that it might be suitable for cool climate areas and rot-prone sites. Data taken over a four-year period showed the following ranges for FPS 17: Brix 22.4-23.3, pH 3.30-3.44, and low titratable acid levels 5.7-7.9. FPS 17 was considered one of the most promising selections in the trial because it consistently produced high quality wines over the years. (Heald and Heald 1999; Trellis Talk 2000)

**Chardonnay FPS 72** was generously donated to the FPS public collection by the Wente family from a production block in the Arroyo Seco appellation that has provided a rich source of Chardonnay plant material to many California growers. That plant material was once known in California as Chardonnay FPS 02A.

The story of **Chardonnay FPS 2A** began in the 1930s at UC Davis. FPS Chardonnay-1 was planted in 1956 in one of the first Foundation vineyards in Davis, described in the 1956 Registered List as “vineyard at the intersection of S.P. R.R. and U.S. 40 in the old Agronomy field.” The source listed for Chardonnay-1 on the old registered lists and FPS records, “I 57-12, UCD.” I 57-12, UCD, is a field location for a Chardonnay vine shown in very old Olmo maps of the Department of Viticulture and Enology’s Armstrong Vineyard Block “I,” and its history can be traced in the old maps back to a source called D3: 19-21, which was a block location in the Armstrong Vineyard in 1930. There the trail goes cold. There was no further evidence in available UC Davis records as to the source of I 57 v12 / D3: 19-21. The oral tradition passed down through three generations of the Wente family indicates that Chardonnay 02A originated as a result of vineyard selection efforts by the Wentes. (Philip Wente, personal communication)

Old FPS distribution records show that the plant material described as Chardonnay-1 in the 1956 Registered list was distributed to FPS customers until 1961 (FPS Distribution Records, 1956-1961). When a new Foundation vineyard was created around 1961, plant material was taken from the old Chardonnay-1 in order to do a heat treatment on it and release it under a different selection number. Chardonnay-1 itself disappeared from the Registered list in 1963 and was removed from the Foundation vineyard in 1967.

The plant material taken from Chardonnay-1 underwent 102 days of heat treatment in 1961-1962. The new selection was renumbered Chardonnay FPS 02A and planted in the new Foundation vineyard (¼ mile south of Straloch Road and ¼ mile west of Hopkins Road) in 1964. (FPS Indexing Records). Chardonnay FPS 02A was first distributed by FPS to customers in 1966. In fact, records from both FPS and Wenté Vineyards show that 19 budsticks of Chardonnay FPS 02A were sent to Wenté Vineyards in 1966 (FPS Distribution Records 1966; Philip Wenté, personal communication) The Wenté records show that the wood from those budsticks was planted in a production block near Greenfield in Monterey County. Wenté Vineyards distributed wood from that production block to many growers throughout the state of California. (Asher 1990) FPS distributed Chardonnay FPS 02A to individual customers, wineries and nurseries until 1967; in 1968 it was removed from the list of Registered vines, and pulled out of the Foundation vineyard because of leafroll positive status in 1969.

Chardonnay FPS 02A resembles the "Wenté clone" that was described above as the "older clone" with small clusters and shot berries. Dr. Jim Wolpert of the Department of Viticulture and Enology at UC Davis describes the vines as clean (no obvious virus symptoms on the leaves), with uniform production and small clusters with frequent "hens and chicks" morphology (*millenderage*). (Jim Wolpert, personal communication) Ralph Riva, Wenté vineyard viticulturalist, indicates that this grape material produces four main flavor components—apple, muscat, pineapple and fruit cocktail—which results in a very good Chardonnay. (Ralph Riva, personal communication)

Despite the fact that Chardonnay FPS 02A had become a popular and widely-used "clone" in the state, FPS no longer had any plant material of that selection growing in the Foundation block after 1969. Around 1991, Dr. Wolpert and Ralph Riva collaborated in the effort to return Chardonnay FPS 02A plant material to FPS. Mr. Riva brought a large amount of FPS 02A wood from a single vine to FPS. That plant material underwent shoot tip tissue culture treatment for virus elimination and first appeared on the FPS Registered list in 2002 as Chardonnay FPS 72.

Robert Mondavi Vineyards has made two of its Chardonnay selections available through FPS. Mondavi's version of the Wenté clone, **Chardonnay FPS 67**, arrived at FPS in 1995 as a proprietary selection. It underwent tissue culture treatment for virus elimination and first appeared on the FPS Registered list in 2002. **Chardonnay FPS 106** came to FPS in 1998 as a proprietary selection from Mondavi's Byron Vineyards in Santa Barbara County. It underwent tissue culture treatment and first appeared on the FPS Registered list in 2005. Both Mondavi selections were released to the FPS public collection in 2006.

**Chardonnay FPS 79 and 80** came to FPS in 1996 from Sterling Vineyards, which farms approximately 1200 acres of vineyards throughout the Napa Valley. FPS Director Deborah Golino collected the plant material from one of Sterling's vineyards. The selections, described as Heritage Sterling muscat clones 1 and 3, consist of two Chardonnay *musqué*-type clones that were favored by both the winemaker and viticulturalist and believed to possess unique qualities. Both selections tested positive for virus and underwent shoot tip tissue culture treatment. They first appeared on the FPS Registered list in 2002.

**Chardonnay FPS 97** is a proprietary Chardonnay selection held at FPS for Chalk Hill Estate Vineyards & Winery in Healdsburg, California. The selection originated from a vineyard planted in 1974 and exhibits cluster morphology similar to an "old Wenté" field selection with loose clusters with many small shot berries. For that reason, Chalk Hill refers to it as the "Shot Berry clone." (Heald and Heald 1999) Chalk Hill's viticulturalist Mark Lingenfelder added, "Chalk Hill Winery still farms 13 acres of that original block planted in 1974 and it continues to be one of our best blocks in terms of wine quality." (Mark Lingenfelder, personal communication) Chardonnay FPS 97 came to FPS with virus in 1996 and subsequently underwent shoot tissue culture treatment. It first appeared on the FPS Registered list in 2003. Chalk Hill has recently incorporated FPS 97 into its ongoing clonal trials begun in 1996 and plans to begin making a separate wine from the vines in 2007 in order to compare selection FPS 97 wine attributes to the other 16 clones in the trial.

**Chardonnay FPS 102** was donated to the FPS public collection in 1997 by Kendall-Jackson Vineyards, who refers to this selection as the "Z clone." The selection originated in Sonoma County and was described as an aromatic (muscat-type) Chardonnay in the nature of the Rued or Spring Mountain clones. Chardonnay FPS 102 underwent shoot tip tissue culture procedures for virus elimination and first appeared on the FPS Registered list in 2003.

A group of Chardonnay clones donated to the FPS public collection in 2002 promises additional clonal variety with

aromatic overtones in Wente clone material. Larry Hyde, a well-respected Napa grape grower who has developed a variety of Chardonnay clones over the years, donated six clones to the public through FPS and the California R&C Program for Grapevines. The 130-acre Hyde vineyard in the Carneros region supplies grapes from these and other clones to more than a dozen wineries, frequently resulting in high quality wines. One of the six selections was released in spring, 2011, and the remaining five are currently undergoing virus elimination treatment at FPS.

**Chardonnay FPS 112** was released in 2011 and is known as the 'Hyde clone.' The plant material originated from a 20-year-old block in the Hyde vineyard in Carneros. The original Hyde clone material suffered from corky bark virus, which Hyde has accommodated by growing it on St. George rootstock. The material underwent micro-shoot tip tissue culture disease elimination therapy at FPS and now tests negative for all viruses. The Hyde clone is productive with high acidity. Larry Hyde explained that the grapes yield an unusual and unique complex flavor profile, characterized by "nutmeg as young wine, followed by a peach-like fruit flavor in one or two months." (Larry Hyde, personal communication)

The additional five clones donated by Hyde to FPS are still undergoing testing and/or disease elimination therapy. They could be released as soon as spring 2013 if they have negative results on all the tests. These additional clones donated by Hyde to FPS are Wente-like Chardonnays which he believes are each unique in terms of flavor profile.

Hyde obtained two of the selections (FPS groups 7245 and 7246)<sup>1</sup> from the former Linda Vista Nursery and characterizes them as "clean and heat-treated" Wente selections. One of the Linda Vista selections (7245) has small clusters and poor set, and the other (7246) has been a favorite of some winemakers due to its small clusters of flavorful small berries. The fourth selection (group number 7247) in this additional group originated from the Wente Livermore vineyard. The fifth selection (group number 7008) is labelled as the Calera clone.

Finally, the sixth selection in the Hyde group (FPS group number 7248) is an aromatic (muscat) grape obtained by Hyde from the Long Vineyards in Napa. Zelma Long indicates that the Long Vineyard was planted above Lake Hennessey in the Napa Valley in 1966 and 1967, using a massal selection that the budder, Rudi Rossi, said was collected from the Martini Vineyards. Larry Hyde took cuttings from the Long vineyard for the material currently at FPS. Ms. Long, who has made wine for Simi Winery from Hyde's Long Vineyard selection, and made wine at Long Vineyard itself, indicates that the two groups of wines

show different character. A grape sensory analysis she conducted at Long Vineyards showed five different flavor expressions in those grapes—yellow apple, citrus, spicy apple (nutmeg and ripe apple), white fruit (pear) and muscat (with citrus overlay)—each occurring in a different percentage in the vineyard, with the yellow apple and the citrus being the most common. (Zelma Long, personal communication)

## CALIFORNIA MT. EDEN CLONES

**Chardonnay FPS 27, 28 and 66** are field selections that originated from a Chardonnay line not derived from the Wente Vineyard.

Paul Masson immigrated to the San Jose, California, area in 1878, and he established a vineyard and winery, La Cresta, in the Santa Cruz Mountains. Wine grapes have been grown in that mountain appellation region since the 1860s, and Chardonnay's value as a base for sparkling wines was recognized by Masson and others at the turn of the century. (Olmo 1971) Masson imported Chardonnay plant material from Burgundy around 1896. A grower named Martin Ray took Chardonnay cuttings from the Paul Masson property and planted them in 1943 in a new vineyard property on a nearby 2000-foot peak called Mt. Eden in the Santa Cruz Mountains. The Chardonnay from that vineyard is called the "Mt. Eden clone." It has been described as "a low-yielding, virus-infected selection with small berries and tight clusters." (Christensen et al. 2003) Two of the wineries that have had success with this clone are Matanzas Creek Winery and Simi Winery.

**Chardonnay FPS 27 and 28** were donated to the FPS public collection by Matanzas Creek Winery in 1984. Merry Edwards was the winemaker at both Mt. Eden Vineyards (1974–1977) and Matanzas Creek (1977–84) and took Mt. Eden plant material to Matanzas Creek. (Smith 1994) The selections donated by Matanzas Creek to FPS were "Matanzas Creek Mt. Eden Vineyard clones 1 and 2." Both selections underwent 61 days of heat treatment at Davis. Selection 27 first appeared on the FPS Registered list in 1992, and selection 28 appeared in 1994.

**Chardonnay FPS 66** was collected in 1994 by FPS Director Deborah Golino from a Chardonnay block that had been planted by Simi Vineyards around 1990, in a newly developed Chardonnay vineyard on Piner Road in the Russian River Valley. The source of the Mt. Eden clone plant material was grower Larry Hyde's vineyard in Carneros. Simi had previously made wine from the Hyde grapes and appreciated the wine for its intensity and depth of feel. (Diane Kenworthy, personal communication) Ms. Long indicates that the vines from the Hyde vineyard were productive and of excellent quality and describes the

<sup>1</sup> Selection numbers are only assigned when a selection has tested negative for virus and has been placed in the R&C Program.



Chardonnay FPS 66 at the Foundation vineyard at FPS. A 'Mt. Eden' clone, the plant material originated in Larry Hyde's vineyard. *Photo by Bev Ferguson*

wine from the Hyde grapes as having “depth and power and texture.” (Zelma Long, personal communication) Dr. Golino, Ms. Kenworthy and Simi winemaker Zelma Long selected four vines from the Mt. Eden clone block at Simi. One of those four vines evolved into Chardonnay FPS 66. Upon its arrival at FPS, selection 66 tested positive for virus and underwent shoot tip tissue culture treatment for virus elimination. It first appeared on the FPS Registered list in 1999.

## FRENCH CLONES

Recent imports from Europe have increased the clonal diversity of Chardonnay plant material available in California. Chardonnay is the leading white wine grape variety in France, where it is grown in Burgundy, Champagne, the Languedoc and a few other areas. In the French system, clonal material is subjected to extensive testing and certification; there are now 28 Chardonnay clones officially certified by the French Department of Agriculture. (Laurent Audeguin, personal communication). Some of the more popular of those French clones are **ENTAV-INRA® nos. 96** (most frequently propagated), **76, 95, 277 and 548**. **Clones 77 and 809** are popular French clones of the *musqué* type.

In the mid-1980s the Oregon Winegrowers' Association and Oregon State University (OSU) collaborated on a project related to a mutual interest in European clonal material. The California Chardonnay clones (in particular, “selection 108,” also known as Chardonnay FPS 04 and 05) did not ripen in a timely manner in their more northern climate. David Adelsheim of Adelsheim Vineyard

in Oregon and Ron Cameron at OSU worked together and successfully established relationships with Professor Raymond Bernard, viticulturalist and regional director at the Office National Interprofessionnel des Vins (ONIVINS) in Dijon, France, and Alex Schaeffer at the Station de Recherches Viticoles et Oenologiques, INRA, Colmar, France. The OSU program (no longer in existence) was able to import eight French Chardonnay clones selected by Bernard from Burgundian vineyards. Mr. Adelsheim appeared in California at a 1985 meeting of University and grape industry personnel and explained the OSU importation project. In response to interest from the California grape and wine industry, OSU agreed in 1987–88 to make some of the French Chardonnay clones (the “Dijon clones”) available for the public collection at FPS.

The French clones sent to FPS from OSU are public and considered “generic.” The source for generic French clones is indicated on the FPS database using the following language: “reported to be French clone xx”. This language is used to distinguish the generic clonal material from trademarked clones that are authorized by the Etablissement National Technique pour l'Amelioration de la Viticulture (ENTAV) and sent from the official ENTAV vineyards and from other sources. Generic clones are assigned an FPS selection number that is different from the reported French clone number. There is no guarantee of authenticity for generic clones.

The generic clones that came to FPS from Dijon via OSU are included in the official French catalogue of certified clones. The reported French source and corresponding selection numbers used to identify these materials at FPS are French 76 (FPS 69), French 77 (FPS 44 and 45), French 78 (FPS 39), French 96 (FPS 70), French 352 (FPS 41) and French 277 (FPS 42, 49 and 51). French 352 was from l'Espiguette and the other clones were from Dijon.

At the time the plant material arrived at FPS (1987-88), the California R&C Program regulations provided that RSP+ (tested positive for Rupestris Stem Pitting virus) plants could not come out of quarantine, so the RSP+ OSU Chardonnays all underwent shoot tip tissue culture treatment. The selections mentioned above appeared on the FPS Registered list gradually over a period of time between 1997 and 2002.

The Etablissement National Technique pour l'Amelioration de la Viticulture (ENTAV) was the first foreign entity to contract with FPS for Chardonnay importation services. ENTAV is an official agency certified by the French Ministry of Agriculture and responsible for the management and coordination of the French national clonal selection program. ENTAV maintains the French national repository of accredited clones and has created an ENTAV-INRA® Authorized clone trademark to identify its official clonal ma-

terials internationally. This trademark is a good indication that the clonal identity of a vine is correct. Trademarked importations come directly from official French source vines. ENTAV retains the exclusive rights to control the distribution and propagation of its trademarked materials, which are only available to the public from nurseries licensed by ENTAV (as of this writing: California Grapevine Nursery, Herrick Grapevines, and Sunridge Nurseries).

The selection numbers used to identify ENTAV-INRA® authorized clones in the FPS collection equate to the same numbers used by the official trademarked clones; i.e., the three trademarked Chardonnay clones sent to FPS in 1997 are labeled authorized Chardonnay ENTAV-INRA® 76, 96 and 548 as well as Chardonnay FPS 76, 96, and 548, respectively. The three selections became registered in the California R&C Program for Grapevines in 2000.

Laurent Audeguin of ENTAV summarized the performance of these three FPS registered selections. ENTAV-INRA® 76 is a regular clone in terms of production and quality; the wines obtained are representative of the variety: aromatic, fine, typical and well-balanced. ENTAV-INRA® 96 demonstrates good vigor and a high level of production; the wines obtained are aromatic, elegant and sharp. ENTAV-INRA® 548 has lower-than-average production due to small and loose clusters with high sugar potential; the wines are aromatic, complex and concentrated with good length. All three selections have good aging potential if yield is controlled. (Laurent Audeguin, personal communication).

Chardonnay is key to many fine sparkling wines. Domaine Mumm contracted with FPS to import five Chardonnay clones from Champagne Perrier-Jouet, France in 1988 for the Domaine Mumm vineyards and the FPS public collection. None of the importations were duplicates of other registered FPS selections. This contract was entered into prior to the time of the ENTAV-INRA® trademark program, so the clones are generic clones and contain the reference “reported to be French xx.” The imported clones with the FPS selection number in parentheses behind the reported French clone number are **French 75 (FPS 43 and 46)**, **French 95 (FPS 37 and 38)**, **French 116 (FPS 83)**, **French 117 (FPS 81)** and **French 125 (FPS 40)**. All of the selections underwent shoot tip tissue culture treatment for virus elimination and first appeared on the FPS Registered list in 1997 (FPS 37, 38 and 46), 1998 (FPS 43), 1999 (FPS 40) and 2002 (FPS 81 and 83).

Some of the French clonal material available in the OSU, ENTAV and Domaine groups has been included in research trials in California. Farm advisor Larry Bettiga evaluated French clones 75, 76, 78, 95 and 96 in his Pacific Vineyard trial in Monterey County. French clones

76, 95 and 96 were in the moderate-to-high yield group with Chardonnay FPS 05, but were more consistent in performance over the years. Clones 95 and 96 had a high number of moderate to large berries per cluster. He found that “under cooler bloom conditions berry set and development has observed to be more uniform.” Vine vigor and °Brix were higher than FPS 04 and 05. Clones 76 and 78 had a greater number of smaller weight clusters with fewer berries than 95 and 96. Clone 75 showed medium cluster weights with above-average numbers of small berries per cluster. Vine vigor was weak to moderate. (Bettiga 2002, unpublished)

Matthew Fidelibus, a UC Cooperative Extension viticulture specialist, included French clone 95 (Chardonnay FPS 37) in his Fresno County trial. The average yield for the four-year period was 23.2 kg/vine, which was not significantly different than FPS 04 and 06. Clone 95 was in the group with the highest average number of clusters per vine but produced an average cluster weight (0.24 kg) between those of FPS 04 (0.29 kg) and FPS 15 (0.20). Although berry weight for all three selections did not differ significantly, the number of berries per cluster for clone 95 was lower than FPS 04 and higher than FPS 15. Clone 95 had similar °Brix and pH levels as FPS 15, with lower titratable acid than both FPS 04 and 15. Clone 95, like FPS 04, often exhibited a high incidence of sour rot in the warmer climate. (Fidelibus et al. 2006)

The Chalk Hill trials in Sonoma included some French clones. In 1996, Clone 75 produced a low yield of 5.4 tons per acre, but the wine was highly rated as rich and concentrated. Clone 95 had the highest yield (6.4 tons per acre) of the four French clones and produced a “rich, well balanced wine.” Clone 95 was one of the five most preferred clones from 1996. Clone 96 was the least-preferred of the four clones. Clones 78 and 352 produced moderate to high yields and good quality wines. (Heald and Heald 1999) The French clones have been included in the ongoing Chalk Hill trials.

Gloria Ferrer vineyard manager Mike Crumly and winemaker Bob Iantosca travelled to Champagne in 1987 and met with the man in charge of clonal research for the Comité Interprofessionnel des Vins de Champagne (CIVC). The CIVC offered them cuttings from the plant material of their choice. Gloria Ferrer arranged for the Saanichton Plant Quarantine Station in British Columbia to import six Chardonnay clones from CIVC in Epernay, France, in 1989. (FPS importation services were very limited then, while new quarantine facilities were under construction in Davis). Saanichton was able to ship these clones to Gloria Ferrer in Sonoma in 1993 after completing all the tests to qualify them for certification in Canada.

In 1996, Gloria Ferrer generously donated cuttings from the six clones to the FPS public collection. FPS performed shoot tip tissue culture virus elimination procedures on all the clones and qualified them for the R&C Program between 2002 and 2004. The reported French clone sources and their corresponding FPS selection numbers are:

**French 118 (FPS 104), French 121 (FPS 99), French 124 (FPS 84 and 98), French 130 (FPS 82), French 131 (FPS 100), and French 132 (FPS 85).**

The final group of French clonal material was imported to Davis by Dr. Austin Goheen for Far Niente Winery in 1981. The material is reported to be French clonal material from a grower named Fetzmann in the Cote d'Or, France. Four separate plants are represented by this group, which are now part of the FPS public collection. **Chardonnay FPS 48 and 50** are from the same clonal material that was labeled "clone 2" by the importer; the plant material underwent both heat treatment (109 days) and shoot tip tissue culture treatment, and first appeared on the FPS Registered list in 1997. **FPS 54** (designated "clone 4" in the shipment) underwent heat treatment (60 days) and tissue culture procedures and became Registered in 1999. **FPS 71** was created using tissue culture (after heat treatment) from the original Burgundian clone and appeared on the FPS Registered list in 2001. Finally, **FPS 73** ("clone 3" in the shipment) underwent both heat treatment (78 days) and tissue culture procedures, and became Registered in the program in 2002.

### ITALIAN CLONES

Chardonnay migrated to Italy some time during the Middle Ages or Renaissance periods. The first documented evidence of the variety in Italy occurred in the 1700s in connection with the Medici family, who facilitated importation of French wine varieties including a "Pineau from Bourgogne." (Calò and Costacurta 1990) The first "official" cultivations of Chardonnay began in the last half of the 19<sup>th</sup> century primarily on the subalpine slopes in northern Italy in order to improve the quality of Italian wines. (Calò and Costacurta 1990; Robinson 2006)

Pinot bianco (Weissburgunder) and Chardonnay (Gelber Weissburgunder) were cultivated together and treated alike in Italy for a time. Field trials conducted between the two world wars at the Istituto Sperimentale Viticoltura in the Veneto region of northeast Italy (Conegliano) raised Chardonnay's profile in northern Italy. The two varieties were clearly separated in 1978 in the National Catalogue of Wine Varieties. (Calò et al. 2001)

Four Chardonnay selections were received by FPS from Conegliano, Italy, in 1984. The selections were labeled Conegliano 6, 7, 10, and 11 and became **Chardonnay FPS 20, 21, 22, and 23**, respectively. All four tested nega-

tive for virus and were not treated. They first appeared on the FPS Registered list in 1990.

The FPS Conegliano clones were used in several clonal trials in California. Larry Bettiga put FPS 20, 22, and 23 in the Pacific Vineyard trial in Greenfield. FPS 22 and 23 had lower yields, attributed to erratic fruit set resulting in lower berry weights and numbers of berries per cluster, plus had shot berries. FPS 20 had larger berries, moderate yields, and lower °Brix than the other selections. (Bettiga 2002) FPS 20 performed in the same relative fashion in the Fresno trial. (Fidelibus et al. 2006) FPS 22 showed high vigor but scored in tier 1 in the wine portion of the Chalk Hill trial in Sonoma. (Heald and Heald 1999)

**Chardonnay FPS 74**, which is known in Italy as SMA 127, came to FPS from Dr. Antonio Calò of the Istituto Sperimentale at Conegliano in 1988. It tested RSP+ and underwent shoot tip tissue culture treatment before appearing on the registered list in 1998. Literature from Italy describes SMA 127 as a grape with excellent production, having clusters of average size. The acidity and sugar content of the must are reportedly high. SMA 127 is suitable as a base for sparkling wine. (Calò and Costacurta 1990)

Another group of Italian Chardonnay selections came from one of the first international entities to contract with FPS for grape importation services, Vivai Cooperativi Rauscedo (VCR) in Italy. VCR is a private nursery cooperative that was formed 70 years ago and currently has an annual production capacity of over 60 million vines. More than 30 years ago, VCR started its own clonal selection program which includes micro vinification for evaluating winegrape clones. In 1997, VCR formed a joint venture with NovaVine Grapevine Nursery in Santa Rosa, California, making NovaVine the exclusive U.S. producer and distributor of the private VCR clones. There are currently three privately controlled VCR Chardonnay clones at FPS: designated **SMA 108 (FPS 86), VCR 10 (FPS 103) and VCR 4 (FPS 105)**, all of which were first registered in 2004. Tom Nemcik of NovaVine explains that "the VCR 4 clone is characterized as a *Musqué* because of its delicate perfume and taste of muscat." (Tom Nemcik, personal communication)

**Chardonnay FPS 18** came to FPS in 1983 with the designation 'Rauscedo 8' and is now in the public collection. That selection did not undergo any treatment and first appeared on the FPS Registered list in 1987. FPS 18 was included in some of the clonal trials in California. In Monterey County it produced moderate yields on clusters of moderate weight. (Bettiga 2002) In Fresno, FPS 18 was in the higher yielding group (22.6 kg/vine) but in the intermediate group for clusters per vine, cluster weight, berries per cluster, and berry weight. It exhibited a high incidence of sour rot. (Fidelibus et al. 2006) In Sonoma

County, FPS 18 produced high yield and early sugar accumulation but did not score highly in the still wine tasting category. (Heald and Heald 1999) This clone is used successfully in Italy as a base for sparkling wine.

## OTHER FOREIGN CLONES

**Chardonnay FPS 16** was imported from Australia's Rutherglen variety collection in 1970 and was given USDA Plant Identification (P.I.) number 364283. The selection tested negative for virus at FPS, but underwent heat treatment for 60 days. FPS 16 appeared on the FPS Registered list in 1980.

In 1990, ampelographer Dr. Jean-Michel Boursiquot examined FPS 16 and opined that it looked different than the characteristic Chardonnay vine and was possibly a tetraploid. In the 1996 FPS Grape Program Newsletter it was announced that, effective November 1996, FPS 16 would be placed "on hold" due to its off-type appearance. "Hold status" indicates that FPS no longer supplies propagation wood of a selection to customers unless the customer specifically requests it, after being informed of potential issues related to the selection. Chardonnay FPS 16 retained its Registered status while it was on "hold" status.

Chardonnay FPS 16 was one of a group of Chardonnays subjected to DNA testing (microsatellite marker comparison analysis) in 2002. The results showed that Chardonnay FPS 16 did not differ in a significant way from the microsatellite marker profiles of the other Chardonnays in the analysis. (Riaz et al. 2002) Dr. Andrew Walker, professor in the Department of Viticulture and Enology at UC Davis, states that Chardonnay FPS 16 resembles traditional Chardonnay morphology enough to identify it as a Chardonnay, but suggests that FPS 16 exhibits clonal variation (leaves with sharper teeth; noticeably larger berries). (Andrew Walker, e-mail to Rhonda Smith)

Finally, there is a proprietary Chardonnay selection from Germany at FPS. Geisenheim has been a viticultural research institute in Germany since 1872. **Chardonnay FPS 25** arrived at FPS from the Geisenheim research institute in 1984 with the designation "Geisenheim selection #1-12". The selection tested negative for virus and first appeared on the FPS Registered list in 1990.

The Chardonnay selections maintained in the FPS collection reflect a large and diverse pool from which growers and winemakers can choose for varietal wines or blending materials. California has created its own selections from the Chardonnay clones imported from France in the 19<sup>th</sup> and 20<sup>th</sup> centuries. Clonal variation has been captured in selections collected from different climate and topographical regions within the state. Additional Chardonnay selections now in the pipeline show promise. Foreign sources of Chardonnay imported from Europe and Australia have

increased the clonal diversity available to California growers and winemakers. Chardonnay has earned its reputation for adaptability and resilience by its performance in California.

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**Summary of FPS Chardonnay selections; their sources, status and where they are available.**

FPS #	Reported Source	Reg Status	Available from	Disease test status	Treatment
04	Martini vineyard in 1964; once known as #108 along with sel. 05	registered in 1969	FPS	all tests negative	heat treated 90 days
05	Martini vineyard in 1964; once known as #108 along with sel. 04	registered in 1969	FPS	all tests negative	heat treated 90 days
06	Martini vineyard in 1964	registered in 1973	FPS	all tests negative	heat treated 164-2 days
08	Martini vineyard in 1964	registered in 1973	FPS	all tests negative	heat treated 114-3 days
09	Chardonnay FPS 08	registered in 1973	FPS	all tests negative	heat treated 102 days
10	Chardonnay FPS 08	registered in 1973	FPS	all tests negative	heat treated 102 days
11	Chardonnay FPS 08	registered in 1973	FPS	all tests negative	heat treated 116 days
12	Chardonnay FPS 08	registered in 1973	FPS	all tests negative	heat treated 116-2 days

FPS #	Reported Source	Reg Status	Available from	Disease test status	Treatment
13	Chardonnay FPS 08	registered in 1973	FPS	all tests negative	heat treated 144 days
14	Martini vineyard/WA K3 v62 in late 1960s	registered in 1974	FPS	all tests negative	heat treated 111 days
15	Prosser, Washington in 1969	registered in 1974	FPS	all tests negative	heat treated 173 days
17	Proprietary selection from Robert Young vineyard in 1982	registered in 1987	Contact Robert Young Vineyard	all tests negative	heat treated 62 days
18	Italy, Rauscedo 8 in 1983	registered in 1987	FPS	all tests negative	none
20	Italy, Conegliano 6 in 1984	registered in 1990	FPS	all tests negative	none
21	Italy, Conegliano 7 in 1984	registered in 1990	FPS	all tests negative	none
22	Italy, Conegliano 10 in 1984	registered in 1990	FPS	all tests negative	none
23	Italy, Conegliano 11 in 1984	registered in 1990	FPS	all tests negative	none
25	Germany, Proprietary selection from Geisenheim in 1984	registered in 1990	Contact VinoUltima, VA	all tests negative	none
27	Matanzas Creek (Mt. Eden clone) in 1984	registered in 1992	FPS	all tests negative	heat treated 61-2 days
28	Matanzas Creek (Mt. Eden clone) in 1984	registered in 1994	FPS	all tests negative	heat treated 61-1 days
37	Champagne Perrier-Jouet, France, in 1988. Reported to be French clone #95	registered in 1997	FPS	all tests negative	shoot tip culture
38	Champagne Perrier-Jouet, France, in 1988. Reported to be French clone #95	registered in 1997	FPS	all tests negative	shoot tip culture
39	Dijon, France, via OSU in 1987-8. Reported to be French clone # 78.	registered in 1998	FPS	all tests negative	shoot tip culture
40	Champagne Perrier-Jouet, France, in 1988. Reported to be French clone #125.	registered in 1999	FPS	all tests negative	shoot tip culture
41	l'Espiguette, France, via OSU, in 1987. Reported to be French clone #352.	registered in 1997	FPS	all tests negative	shoot tip culture
42	Dijon, France, via OSU in 1987-8. Reported to be French clone #277.	registered in 1997	FPS	all tests negative	shoot tip culture
43	Champagne Perrier-Jouet, France in 1988. Reported to be French clone # 75.	registered in 1998	FPS	all tests negative	shoot tip culture
44	Dijon, France, via OSU in 1987-8. Reported to be French clone #77.	registered in 1998	FPS	all tests negative	shoot tip culture
45	Dijon, France, via OSU in 1987-8. Reported to be French clone #77.	registered in 1997	FPS	all tests negative	shoot tip culture
46	Champagne Perrier-Jouet, France, in 1988. Reported to be French clone #75.	registered in 1997	FPS	all tests negative	shoot tip culture

FPS #	Reported Source	Reg Status	Available from	Disease test status	Treatment
48	Cote d'Or, France, in 1981.	registered in 1997	FPS	all tests negative	shoot tip culture
49	Dijon, France, via OSU in 1987-8. Reported to be French clone #277.	registered in 1997	FPS	all tests negative	shoot tip culture
50	Cote d'Or, France, in 1981.	registered in 1997	FPS	all tests negative	shoot tip culture
51	Dijon, France, via OSU in 1987-8. Reported to be French clone #277.	registered in 1999	FPS	all tests negative	shoot tip culture
54	Cote d'Or, France, in 1981.	registered in 1999	FPS	all tests negative	shoot tip culture and HT 60-1 days
66	Russian River Valley, CA, in 1994. Simi/Mt. Eden clone.	registered in 1999	FPS	all tests negative	shoot tip culture
67	Wente clone from Robert Mondavi Vineyards, Napa, California in 1995.	registered in 2002	FPS	all tests negative	shoot tip culture
69	Dijon, France, via OSU in 1987-8. Reported to be French clone #76.	registered in 2002	FPS	all tests negative	shoot tip culture
70	Dijon, France, via OSU in 1987-8. Reported to be French clone #96.	registered in 2001	FPS	RSP+	shoot tip culture
71	Cote d'Or, France, in 1981.	registered in 2001	FPS	all tests negative	shoot tip culture and HT 60-1 days
72	Wente clone from production block in Monterey County, CA, in 1991.	registered in 2002	FPS	all tests negative	shoot tip culture
73	Cote d'Or, France, in 1981.	registered in 2002	FPS	all tests negative	shoot tip culture and HT 78 days
74	SMA 127 from Conegliano, Italy, in 1988.	registered in 1998	FPS	all tests negative	shoot tip culture
76	French ENTAV-INRA® 76 authorized clone, France, in 1997	registered in 2000	Contact Sunridge Nurseries or Herrick Grapevines	all tests to qualify for Foundation stock negative	none
79	Sterling Vineyards, CA, in 1996	registered in 2002	FPS	all tests negative	shoot tip culture
80	Sterling Vineyards, CA, in 1996	registered in 2002	FPS	all tests negative	shoot tip culture
81	Champagne Perrier-Jouet, France in 1988. Reported to be French clone # 117.	registered in 2002	FPS	all tests negative	shoot tip culture
82	Epernay, France, via Saanichton, Canada, and CA vineyard in 1996. Reported to be French clone #130.	registered in 2002	FPS	all tests negative	shoot tip culture
83	Champagne Perrier-Jouet, France, in 1988. Reported to be French clone #116.	registered in 2002	FPS	all tests negative	shoot tip culture

FPS #	Reported Source	Reg Status	Available from	Disease test status	Treatment
84	Epernay, France, via Saanichton, Canada, and CA vineyard in 1996. Reported to be French clone #124.	registered in 2002	FPS	RSP+	shoot tip culture
85	Epernay, France, via Saanichton, Canada, and CA vineyard in 1996. Reported to be French clone #132.	registered in 2002	FPS	all tests negative	shoot tip culture
86	SMA 108, from Rauscedo, Italy, in 1999.	registered in 2004	Contact NovaVine Grapevine Nursery	RSP+	none
96	French ENTAV-INRA® 96 authorized clone, France, in 1997	registered in 2000	Contact Sunridge Nurseries or Herrick Grapevines	all tests to qualify for Foundation stock negative	none
97	Chalk Hill Winery, CA, in 1996	registered in 2003	Contact Chalk Hill Vineyards	all tests negative	shoot tip culture
98	Epernay, France, via Saanichton, Canada, and CA vineyard in 1996. Reported to be French clone #124.	registered in 2003	FPS	all tests negative	shoot tip culture
99	Epernay, France, via Saanichton, Canada, and CA vineyard in 1996. Reported to be French clone #121.	registered in 2003	FPS	all tests negative	shoot tip culture
100	Epernay, France, via Saanichton, Canada, and CA vineyard, in 1996. Reported to be French clone #131.	registered in 2003	FPS	all tests negative	shoot tip culture
102	Kendall-Jackson, CA, in 1997	registered in 2003	FPS	all tests negative	shoot tip culture
103	VCR 10, from Rauscedo, Italy, in 1998.	registered in 2004	Contact NovaVine Grapevine Nursery	RSP+	none
104	Epernay, France, via Saanichton, Canada and CA vineyard, in 1996. Reported to be French clone # 118.	registered in 2004	FPS	all tests negative	shoot tip culture
105	VCR 4, from Rauscedo, Italy, in 1998	registered in 2004	Contact NovaVine Grapevine Nursery	all tests negative	shoot tip culture
106	Robert Mondavi's Byron Vineyards in Santa Barbara, California, in 1998	registered in 2005	FPS	all tests negative	shoot tip culture
112	The Hyde clone, Larry Hyde vineyard in Napa County, California, in 2002	Provisional	FPS	all tests negative	shoot tip culture
548	French ENTAV-INRA® 548 authorized clone, France, in 1997	registered in 2000	Contact Sunridge Nurseries or Herrick Grapevines	all tests to qualify for Foundation stock negative	none