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Wildfires and Smoke Exposure Create Contracting and Crop Insurance Challenges for California's Wine Industry

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In recent years, droughts and climate change have increased the prevalence of wildfires across the globe. In the United States, these fires tend to occur in Western states—the part of the country also known for wine production. Wildfires not only affect public safety and the environment but also wreak havoc on the livelihoods of wine grape growers and wineries alike through direct destruction of vineyards and tasting rooms and indirect ruination of grapes due to smoke exposure. While still not fully understood, smoke exposure can lead to smoke taint, an ashy, burnt aftertaste in wine.

In 2020 alone, \$601 million of Californian wine grapes went unharvested due to smoke exposure concerns (Downey Brand, LLP, 2021). The U.S. Department of Agriculture's Risk Management Agency (RMA), which oversees crop insurance programs, paid \$227,101,806 in associated crop insurance claims to growers (Yasui et al., 2021). While the numbers are not yet in, dry conditions in California led to another busy fire season in 2021. As a result, grape growers and wineries are altering contractual terms to include specific provisions for smoke events and purchasing crop insurance policies at record levels to help mitigate the risks associated with future wildfires and potential smoke taint.

Prevalence of Wildfires

Climate change has increased the incidence of drought, warmer temperatures, and dry weather in various parts of the world, with the Western United States a particularly hard-hit area. Overall, global temperature trends are rising (NOAA, 2021). The five warmest years to date were 2015, 2016, 2017, 2019, and 2020, with 2016 recorded as the warmest year in history (NOAA, 2021). Additionally, from 1973 to 2013, fire seasons have lengthened across 25.3% of Earth's vegetated surface (Jolly et al., 2015).

Since 2015, California has experienced extremely destructive fire seasons, with several of the largest fires affecting key wine-growing counties. The most affected

areas have been Lake County in 2015, Carmel Valley (Monterey County) in 2016, Napa Valley in 2017, Mendocino and Lake Counties in 2018, and Alexander Valley (Sonoma County) in 2019. In 2020, perhaps the worst fire season to date, fires were widespread throughout California, burning over 4,257,863 acres; Sonoma and Napa Counties were hit particularly hard (Cal Fire, 2021). In 2020, the Glass, August Complex, and Lake Napa Unit (LNU) Lightning Complex fires collectively burned more than 1,463,352 acres (Insurance Information Institute, 2021). The Glass fire was one of the top ten costliest fires in the United States, burning 67,484 acres of Napa and Sonoma Counties and 1,520 structures and costing \$2.9 billion (Insurance Information Institute, 2021). The LNU Lightning Complex fire in August 2020 burned 363,220 acres in Napa, Sonoma, Lake, Yolo, and Solano Counties (Insurance Information Institute, 2021). The Tubbs fire burned 36,807 acres in Napa and Sonoma Counties in October 2017, considerably less than other fires, but ranks as another of the top ten costliest fires (Insurance Information Institute, 2021).

Wildfires are not unique to the Western United States. During the 2019–2020 Australian fire season, over 17 million hectares (~42,007,914 acres) burned across New South Wales, Victoria, Queensland, the Australian Capital Territory, Western Australia, and Southern Australia (Richards, Brew, and Smith, 2020). These fires were the largest in scale in modern record for New South Wales, Australia's wine-growing region, where many growers lost their harvest due to burned vineyards or smoke taint (Richards, Brew, and Smith, 2020). The North Mediterranean region—with the wine-producing countries of Spain, Italy, Portugal, and Greece—experienced more than 56,000 fire incidents each year between 2009 and 2018 (Hernández, 2019). In Europe's 2017 fire season, there was a 30% increase in wildfires in June and July compared to the previous year, and rainfall levels fell by 30% (*The New York Times*, 2017). During that year, 180,000 hectares burned in Spain and

540,000 hectares burned in Portugal (Hernández, 2019). As global temperatures and incidences of drought increase, wine-growing regions will continue to face challenges associated with fires and smoke.

Smoke Taint

Currently, the link between smoke exposure and smoke taint is not well understood. When wildfires occur, grapes exposed to smoke come into contact with volatile phenols, also known as aromatic compounds, which can produce an undesirable smoky taste in wine made from smoke-exposed grapes. Kennison et al. (2007) exposed Australian grapes on the vine to straw-derived smoke for one hour. Smoke-exposed grapes were then fermented according to two wine-making treatments; control wines were made with nonexposed grapes. Sensory evaluations found that wine made from the smoked-exposed grapes had a smoky, burnt, dirty, and earthy taste that was not present in the control wines. During combustion of lignin—an organic polymer found in the cell wall of plants that gives the cell wall its rigidity and varies between softwood, grass, and hardwood—a range of phenol, guaiacol, syringol, and various cresols are formed as volatile organic compounds (VOCs) (Krstic, Johnson, and Herderich, 2015). The smoke-exposed wines contained volatile phenols—including guaiacol, 4-methylguaiacol, 4-ethylguaiacol, and 4-ethylphenol, eugenol, and furfural—that were not detected in the control wines (Kennison et al., 2007). Regression analysis revealed that guaiacol, 4-methylguaiacol, 4-methylsyringol, phenol, o-cresol, and m-cresol were the most important volatile phenols associated with an ashy and smoky aftertaste (Krstic, Johnson, and Herderich, 2015). While these compounds are believed to be linked to smoke taint, it is likely not a comprehensive list as the science is relatively new.

Volatile phenols can enter the grape through its waxy cuticle and bind to the grape's sugar molecules in a process called glycosylation (Ball, 2019). The glycoside bond (the joined phenol and sugar) stabilizes and creates a nonvolatile phenol (Ball, 2019). Volatile phenols are aromatic compounds; by stabilizing them, the sensory properties that create the smoky, ashy taste are not perceptible (Ball, 2019). During the fermentation process, the glycoside bonds are broken and the volatile phenols are once again perceptible (Ball, 2019). The release of the volatile phenols continues during the bottle-aging process and acid in saliva releases these phenols when the wine is tasted (Ball, 2019). Hence, the effects of smoke exposure may not be detectable through sensory evaluation of the grapes if these glycoside bonds are present, yet the smoky, ashy taste will surface during fermentation and be present in the wine.

Smoke taint is thought to depend on when in the growing season the smoke exposure occurs, grape varietal, fuel source, how long the smoke has been in the air, duration of exposure, proximity of the fire, and wind speed and

direction, among other factors. Red wines tend to be more susceptible to smoke taint because they are harvested later in the season, when the worst wildfires tend to occur, and they stay in their skins during the fermentation process, exposing them to more of the VOCs (Flavelle, 2021). Data from a study of prescribed burns of two pine-dominated forests in Georgia suggests that VOCs in smoke can travel substantial distances; samples of VOCs were collected 20–25 km downwind (Lee et al., 2005). The study found that VOC levels were higher from smoldering burns than from flaming burns (Lee et al., 2005). Once VOCs are released into the atmosphere, they begin to degrade; the atmospheric lifetime of a VOC depends on the fuel compositions and environmental conditions during aerial transport (Krstic, Johnson, and Herderich, 2015). The atmospheric lifetime of guaiacol is about two hours (Coeur-Tourneur, Cassez, and Wenger, 2010). More research is needed to understand aerial transport of VOCs, when smoke exposure is likely to lead to smoke taint, and how far the potential effects of smoke exposure extend from a wildfire.

Currently, no horticultural barrier products or vineyard management practices have been determined to reduce the impacts of smoke exposure (Silverado Farming Company, n.d.; Australian Wine Research Institute, 2021). Practices used during harvesting, juice preparation, and winemaking appear to be important factors affecting how much, if any, smoke can be perceived in wine produced with smoke-exposed grapes because the volatile phenols and their glycosides are located in the grape skins (Australian Wine Research Institute, 2021). On-going research across the globe aims to better understand smoke taint and develop winemaking techniques that will minimize the effects of smoke exposure by removing smoke taint from the wine (Pomranz, 2021).

California Wine Market

While smoke exposure is a challenge across the globe, we focus our discussion on California as it is America's top wine producing state and the fourth leading wine producer worldwide (Wine Institute, 2020). The retail value of California wine in 2020 and 2019 was \$40 billion and \$43.6 billion, respectively (Wine Institute, 2020). California wines generate \$1.36 billion in exports, accounting for 95% of U.S. wine exports (Wine Institute, 2020). California wineries produce wine at all price points, ranging from value (\$4–\$10/bottle) to icon (\$200 or more) (Mowery, 2019). Napa County produces only 4% of California's wine by volume (Napa Valley Vintners, 2021) but accounts for more than 78% of California wineries' revenue (Stonebridge Research Group, 2017). The state economic impact of wineries is estimated to be \$57.6 billion (Wine Institute, 2020), about 21% of which is from Napa (MFK, 2005). Neighboring Sonoma County generates \$1.2 billion in tourism dollars and contributes \$8 billion to the U.S. retail value of wine (Sonoma Wine, n.d.)

Although California's wine industry has grown for over two decades at a predictable rate of 3%, growth rates started to decline several years ago (Maixner, 2020; Quackenbush, 2019). The slow growth rates are mainly attributed to Millennials not reaching for finer wines and Baby Boomers' consumption declining slowly over time (McMillian, 2021). Further, the industry was particularly hard hit by stay-at-home and shelter-in-place orders associated with the COVID-19 pandemic. On-premise sales dropped drastically with the closure of bars and restaurants; while many wineries saw growth in retail and direct-to-consumer sales, growth in these segments did not offset declines in on-premise sales (McMillian, 2021).

Contracting

In California, approximately 95% of wine grapes are grown under contract (Blake, 2013). The vast majority of these contracts are written on template contracts drafted by lawyers or grower representative organizations. Grape crush contracts are typically negotiated in the spring through early fall in advance of harvest, with a contract length of three to five years (Blake, 2013). These contracts, referred to as grape purchase agreements, frequently contain an evergreen clause, which automatically renews the agreement if it is not renegotiated or properly cancelled by a specified date, leading to long-term relationships between growers and wineries.

The agreement is either written on tonnage or acreage. Since yields are difficult to predict precisely, if the contract is written on acreage, the contract will stipulate the target tonnage and maximum tonnage that the winery is obligated to purchase. In some cases, the contract also stipulates which party is responsible to make up shortages if the target tonnage is not achieved. Unlike many other agricultural commodities, wine grapes are a heterogeneous product commanding higher prices for higher quality. Hence, higher yields are not always preferable as they might indicate lower-quality fruit. Thus, the contract may indicate specific vineyard management practices such as crop thinning or canopy management techniques to reduce yields and maintain fruit quality.

The agreement also stipulates the price (\$/ton), which is often stated as a percentage of the average price for the crush pricing district for the prior crop year. As shown in Figure 1, the state of California is broken down into 17 price reporting districts. The Clare Berryhill Grape Crush Report Act of 1976 requires every California processor that crushes grapes to report the total tonnage of crushed grapes, tonnage of purchased grapes, and associated prices to the Secretary of Food and Agriculture by varietal and reporting district where the grapes were grown.

Additionally, the contract states quality standards, which can include acceptable levels of Brix (sugar), acid, and

pH; material other than grapes (MOG), such as leaves, stems, and other debris; defects (disease, bird peck); color; and flavor (Lake, 2019). Grape purchase agreements generally stipulate that the purchaser (winery) may reject delivery or renegotiate the price if the agreed-upon quality parameters are not met. While language on smoke exposure is becoming more common, the majority of contracts in 2020 did not contain any language about smoke exposure, subsequent testing, or set tolerance limits for compounds believed to be predictors of smoke taint (Downey Brand, LLP, 2021).

The contract also outlines when harvest should occur as well as delivery and payment terms. The agreement typically contains language regarding remedies and dispute resolution including choice of law and venue, contingencies for unforeseeable circumstances, and means of settling disputes.

Grapes that are not sold via contracting are sold on the spot market at harvest or crushed and sold on the bulk (juice) wine market. Typically, grapes sold on the spot market command lower prices than those sold via contracts. Grapes crushed and sold as juice yield significantly lower prices than those sold on the spot market.

Rejection of Grapes

In recent years, wineries have rejected delivery of grapes due to concerns about smoke exposure. While wineries cannot know with certainty that grapes exposed to smoke will lead to tainted wine, wineries reject grapes out of concerns that wines produced with the smoke-exposed grapes could be tainted and either unmarketable or of lower quality and hence would have to be sold at a lower price point. A record number of grapes were rejected in 2020. Although the majority of grape purchase agreements made no mention of smoke exposure, many wineries rejected grapes, arguing that quality degradation resulting from smoke exposure was implicitly covered by other generic quality standards language in their contracts (e.g., verbiage such as "grapes should be suitable for the production of premium quality wine"). While it is difficult to calculate the exact tonnage of unharvested grapes, it is estimated that 165,000–325,000 tons of wine grapes went unharvested in 2020 because of smoke-taint concerns in California alone (Downey Brand LLP, 2021). Using data from the 1996–2020 California Final Grape Crush Reports, Figure 2 shows that 3,411,000 tons of grapes were crushed in California in 2020, down 20% from 2018. Figure 3 shows the tonnage of crushed wine grapes from 1996 to 2020 for Pricing Districts 1–5, which account for the lion's share of high-value wine production. Both Sonoma (District 3) and Napa (District 4) Counties crushed 46% fewer wine grapes in 2020 than in 2018.

Even those growers whose contracts contained language regarding contingencies for smoke exposure

Figure 1. Map of California Grape Pricing Districts



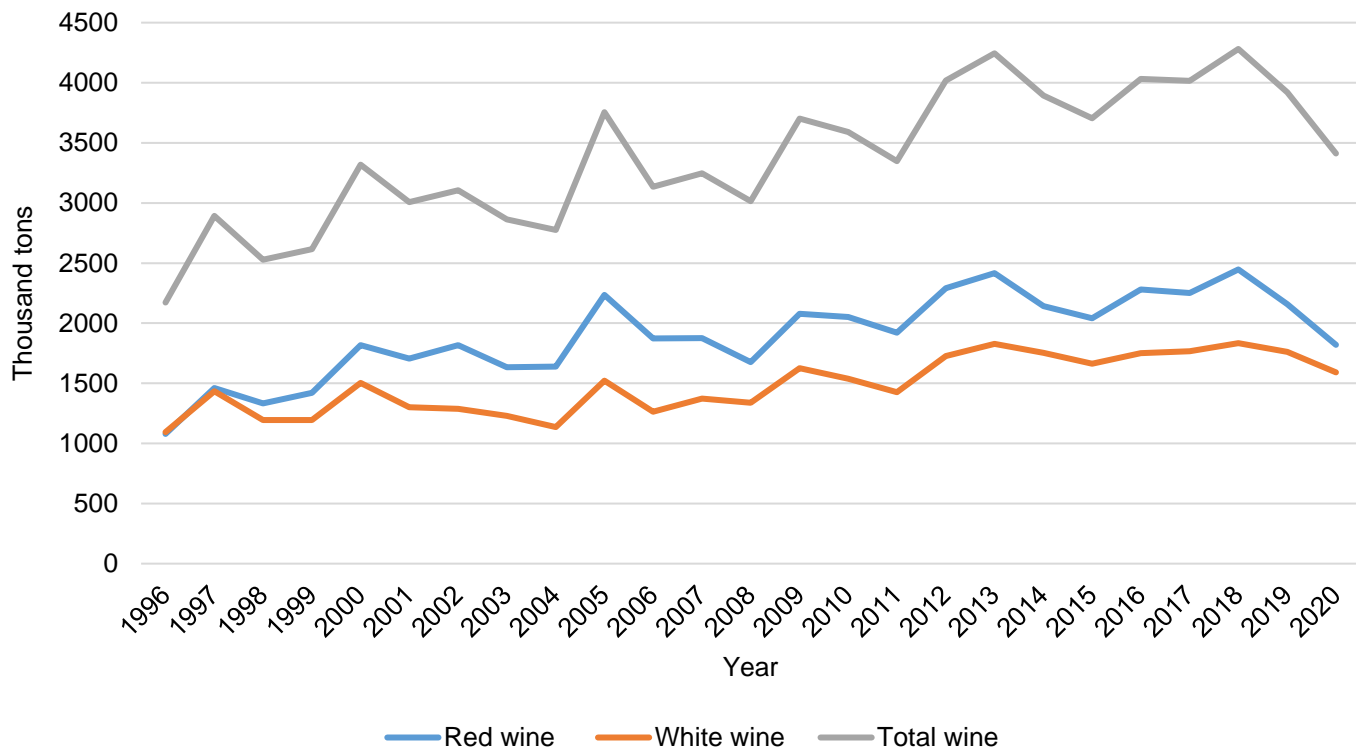
Source: U.S. Department of Agriculture (2021a).

still faced challenges. The severity of the 2020 wildfires in California led to extremely high demand for third-party tests used to detect the presence of elevated levels of

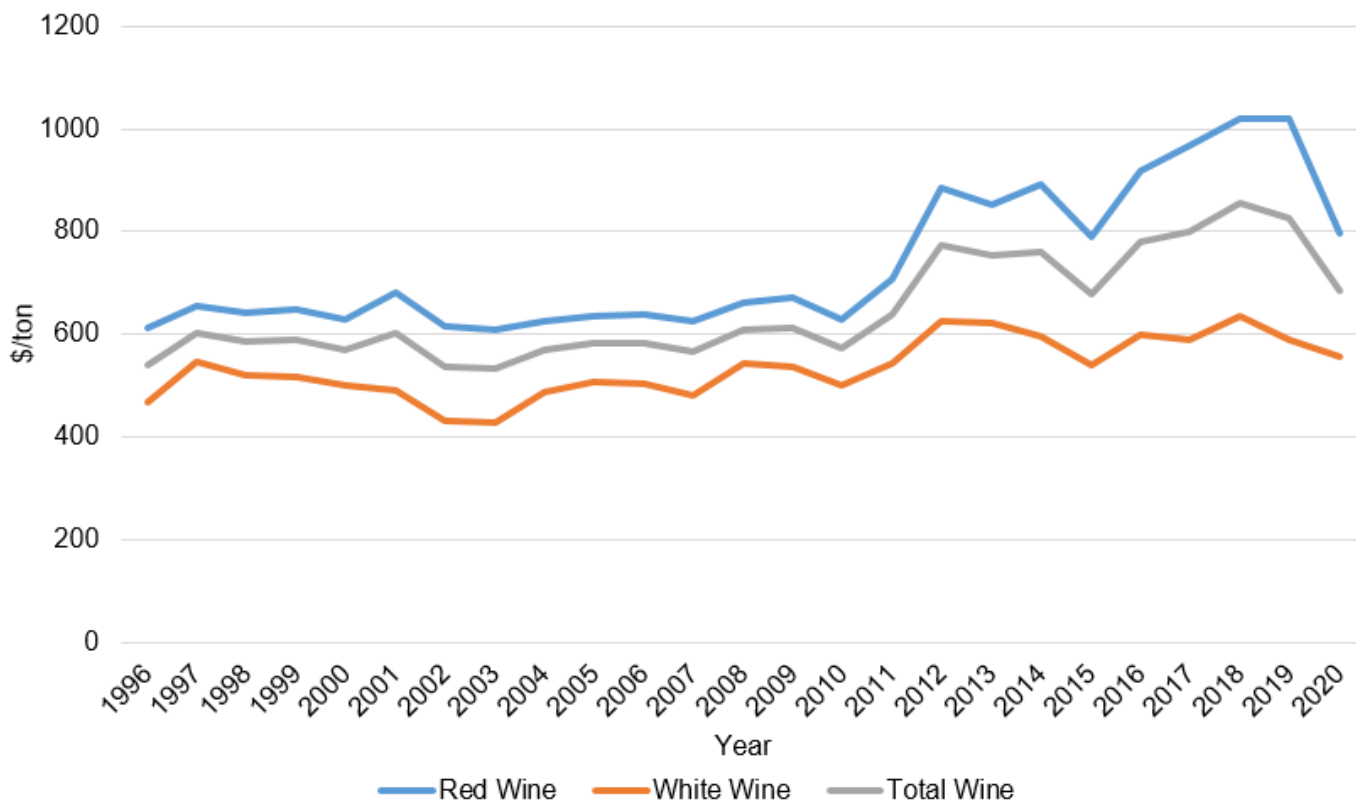
guaiacol, 4-methyguaiacol, and other VOC compounds believed to be linked to smoke taint, leaving certified and accredited laboratories severely backlogged. Some

Figure 2. California Wine Grape Crush, 1996—2020

(a) Tonnage

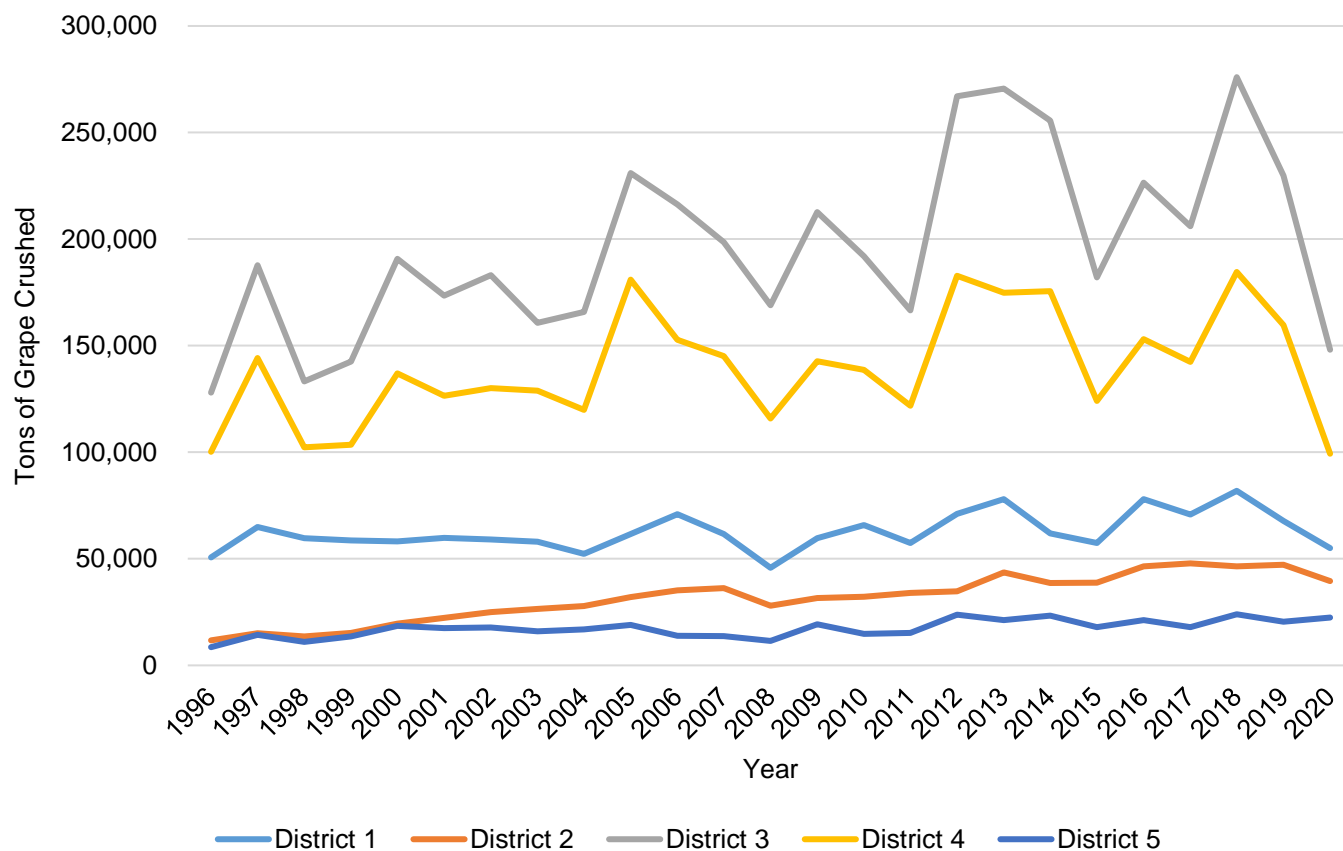


(b) Price (\$/ton)



Source: U.S. Department of Agriculture (2021a).

Figure 3. Total Wine Grape Crush Tonnage in Districts 1–5, 1996–2020



Source: U.S. Department of Agriculture (2021a).

growers reported waiting four to five weeks to receive results, while others reported not getting the results until after harvest (Ness, 2021). Delaying harvest while awaiting test results can affect yields and sugar content, potentially triggering rejection on other quality parameters. Discrepancies about which party (grower or wineries) should have to bear the expense of the testing, which costs between \$160–\$360 per test (Twin Arbor Labs, 2021), and what levels of the precursor compounds signified the presence of smoke taint, were also points of contention. These discrepancies highlight the larger issue: Which party bears the burden of proof? Is it the winery’s responsibility to prove that the grapes have been damaged or is it the grower’s responsibility to prove that they meet the quality standards?

Once rejected, growers must find an alternative outlet for their grapes. Often this means crushing them and selling them at a lower price in the bulk wine market or filing a crop insurance claim. If growers know prior to harvest the grapes will be rejected and that they do not have an alternative outlet to market them, they may choose to forgo harvesting to spare the associated costs. The amount of the savings will depend on when in the growing season the grapes were deemed to be unmarketable and abandoned. If the smoke event and

abandonment occur early in the season, then the grower may avoid not only the costs associated with harvesting but also other farming costs such as canopy management, thinning, fertilizer, and irrigation. These costs vary significantly from grower to grower, varietal to varietal, and vineyard to vineyard (Goettsch, 2019).

Wineries rejecting grapes also face challenges; they must either find alternative sources of grapes or forgo producing wine. While it is difficult to quantify and may take years to know for certain, it is estimated that 80% of Napa wineries did not produce a vintage in 2020 (Moran Williams and Smith, 2021).

There is also speculation that some wineries used the wildfires as a convenient excuse to cancel contracts as spot market and bulk wine prices were slumping from oversupply. Even prior to the pandemic, grape supply was outpacing demand. Growers were planting approximately 30,000 acres of new vineyards each year; in 2019, there were about 590,000 fruit-bearing acres (Maixner, 2020). In 2019, spot market prices were down 25%–50% or more depending on varietal (Ness, 2019). Grape crush prices in California for red wine varietals were \$1,020/ton in 2019 but dropped to \$795/ton in 2020, a 22% decline (Figure 2); however, it cannot be

determined from the aggregate data how much of the price decline is due to quality degradation and grapes from high value areas such as Napa being not being crushed versus other supply and demand factors.

Crop Insurance

Wine grape growers can purchase federally subsidized crop insurance to protect against multiple perils, including degradation of quality due to smoke exposure. The percentage of California's wine grape acres that are insured declined slightly in recent years, from 82% in 2016 to 76% in 2020 (USDA, 2021). Approximately 77% of California's wine grape growers had insurance in 2020; in contrast, only 32% of growers in Oregon had coverage (Kirschenmann, 2021).

Growers can purchase either a Catastrophic Risk Protection (CAT) or a buy-up Actual Production History (APH) policy to insure their yields. CAT coverage is fixed at 50% of the grower's average yield and 55% of the price election, while growers choosing a APH policy can select a coverage level between 50%–85% of their historic yield (USDA, 2019). The price used to calculate indemnities is set by the RMA for each varietal and grape crush pricing district using data from previous California Grape Crush Reports. Growers can select from a variety of coverage options such as Contract Pricing, Hail and Fire Exclusion, Supplemental Coverage Option (SCO), Yield Adjustment, and Actual Production History Yield Exclusion (USDA, 2019). The Contract Pricing option allows the price stipulated in the grower's grape purchase agreement (up to two times the RMA set price for the varietal) to be used as the price to calculate the indemnity payment should one occur (Yasui et al., 2021).

The RMA requires actual physical damage from an insurable cause of loss to process a claim. Thus, a lab test is required to substantiate that the loss is due to smoke for a grower to receive an indemnity payment associated with a smoke taint claim. The RMA requires a test showing elevated levels of guaiacol and 4-methyguaiacol but does not stipulate the level or set a benchmark (Yasui et al., 2021). The test can be conducted on fresh berries, after a micro-fermentation (bucket fermentation) to break the glycoside bonds, or after fermentation; however, juice can be tested only if the sample is from grapes that were not commingled with grapes grown on other vineyard blocks (Yasui et al., 2021). Growers can file a claim if (i) the fruit is rejected before harvest, (ii) fruit is harvested and then juice needs to be disposed of, or (iii) fruit is harvested and made into wine, but the price is reduced due to smoke (American AgCredit, 2020). The last option requires a loss adjuster to verify or estimate the price reduction due to a degradation of the quality of the grapes. Typically, a rejection letter from the winery stating that the grapes are being rejected or the price has been reduced because of smoke exposure is necessary to process the claim. For the 2020 crop year, Napa and Sonoma

County growers received \$91.8 million and \$80.2 million in claims, respectively (Yasui et al., 2021). Uninsured growers could obtain assistance in 2017, 2018, and 2019 through USDA disaster assistance programs (WHIP and WHIP+) aiding agricultural producers impacted by wildfires, hurricanes, and other natural disasters (USDA, 2020).

Lawsuits

The rejection of grapes without corroborating evidence strained relationships between growers and wineries and led to several lawsuits when the grower did not have insurance, the insurance claims were denied, or the indemnity payment did not cover the loss. For example, in 2018, the owner of Copper Cane wineries conducted sensory evaluations and rejected contracted grapes worth \$4 million (Stiles, 2018). The growers claimed this was unjust because samples of the fruit were not taken to an approved lab for testing (Stiles, 2018). In 2020, Gallo Vineyards sued an affiliate of Napa Valley's Long Meadow Ranch for \$420,000 associated with rejected contracted fruit, and Napa Vineyard owners Dan and Jerry Linstad sued the owner of Anderson Conn Valley winery for rejecting \$536,208 worth of fruit (Quackenbush, 2021a). Wineries are also taking legal action against growers. A Lake County winery is suing a grower for \$330,266 to replace oak tanks, barrels, and other storage vessels allegedly ruined by smoke-exposed grapes (Quackenbush, 2021b).

Recommendations

Since horticultural practices to reduce the impact of smoke exposure are currently not available, wine grape growers must rely on three key risk management strategies to help mitigate the impacts associated with smoke exposure: (i) inclusion of smoke provisions in contracts, (ii) crop insurance, and (iii) cost-benefit analysis to determine whether smoke-exposed grapes should be abandoned. A recent report commissioned by the Allied Grape Growers (AGG) and California Association of Winegrape Growers (CAWC) and drafted by the law firm of Downey Brand, LLP, recommends that grape growers renegotiate contracts to include specific language regarding smoke exposure. However, the report cautions against a one-size-fits-all approach. Smoke taint research is relatively new, and no set threshold for smoke taint compounds have been defined.

The contracting parties must consider the varietal, intended use of grapes (value wine versus premium wine), and the sensitivity of the winemaker to smoke. Specifically, the contract should set tolerance levels of the key compounds believed to be predictors of smoke taint, a range at which the price would be renegotiated, and levels that would trigger rejection by the winery. The contract should outline when testing should be done, the methodology (lab, sensory evaluation, or both) and sampling procedures, and who will perform the tests and bear the cost as well as contingencies should testing be

unable to be conducted as planned. The report cautions against verbiage such as “free of smoke taint,” as there is no consistent interpretation of the phrase (Downey Brand, LLP, 2021). Wines naturally have levels of phenols present from microbial sources and from aging in oak barrels (Ward, 2015). Phenol levels as low as 0.5 parts per billion can be measured, which may lead to falsely claiming that grapes have smoke taint.

The contracting parties may also consider adding an insurance clause requiring the grower to purchase crop insurance. Even if not stipulated in their purchase agreement, growers should consider purchasing crop insurance, as it is an important safety net when smoke exposure does occur. The RMA reports a 6% increase in the number of Californian wine grape insurance policies written in 2021 compared to 2020 (Yasui et al., 2021). The closing date to write new policies is January 31.

In addition, growers must weigh the costs and benefits of abandoning the vineyard following a smoke event. Laboratory testing is essential in determining if the crop should be abandoned. The cost savings of abandonment will depend on when in the season the crop is abandoned, the harvest technique used by the grower,

and labor costs as well as the extent of the quality reduction of the grapes due to the exposure. Growers should note that crop insurance indemnities are reduced by \$200/acre if the grapes go unharvested (American AgCredit, 2020).

Further, the RMA must continue to develop transparent quality loss adjustment procedures. Heterogeneity of wine grapes can make quality adjustment calculations challenging. Adjustments often rely on reduction in the price received for the commodity as the basis of calculation. This becomes more complicated and difficult to verify when there is vertical integration with the grower also being the wine producer (Yasui et al., 2021).

The future of the California wine industry depends on the ability of growers and wineries to come together to tackle issues associated with smoke exposure. Unfortunately, wildfires and smoke are here to stay and will continue to plague growers and wineries. Employing and developing effective risk management strategies that benefit both parties is necessary for the long-term survival of the industry.

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