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Crop Fact Sheet series

Excerpted from **The Southwest Regional Climate Hub and California Subsidiary Hub Assessment of Climate Change Vulnerability and Adaptation and Mitigation Strategies** *(July 2015)*

This report describes the potential vulnerability of specialty crops, field crops, forests, and animal agriculture to climate-driven environmental changes. In the report vulnerability is defined as a function of exposure to climate change effects, sensitivity to these effects, and adaptive capacity. The exposure of specific sectors of the agricultural and forestry industries varies across the region because the Southwest is climatically and topographically diverse. The purpose of this analysis is to describe regional vulnerabilities to climate change and adaptive actions that can be employed to maintain productivity of working lands in the coming decades.

The report can be accessed here: http://swclimatehub.info/files/Southwest-California-Vulnerability-Assessment.pdf

Grapes

Vitis vinifera (Vitaceae)

Grapes are native to the Mediterranean, and they prosper in California's Mediterranean climate. California grows more than 90% of the nation's wine grapes and 99% of raisin grapes [2] (Figure 1), making it the top raisin producer and one of the top wine producers in the world. Grapes are grown ubiquitously across the state under a range of environmental conditions; 85% of all California counties support grape production [3]. Grapes and almonds vie for first place as California's most valuable crop.

Six varieties of raisin grapes, more than 31 varieties of table grapes, more than 45 varieties of white wine grapes, and more than 72 varieties of red wine grapes are grown in California [3]. Specific varieties are selected with respect to the regional growing conditions. Wine grapes make up 57% of the state's total grape crop by value, while table grapes are 23% by and raisin grapes are 20% [2]. Wine grapes are the most widely distributed, while table and raisin grapes are typically grown in the southern part of the Central Valley and in the Coachella Valley.

Wine grapes are usually drip-irrigated. To meet evaporative demand, wine grapes would need 30-50 inches of irrigation for the growing season, but optimal or near-optimal yields can be achieved when irrigation is only 50-75% of evaporative demand [4]. Table and raisin grapes are not as drought-tolerant, but can achieve full yield potential with less irrigation also. Table and raisin grape producers have been switching from the traditional flood irrigation systems to the water-saving drip irrigation commonly used in wine grape production. Grapes can also be dry-farmed, but they must have adequate access to water.

Grapes can survive a wide range of temperatures (below freezing to over 37.8°C (100°F)), and are widely cultivated. However, wine grapes may not achieve optimum yield or flavor if conditions depart from the average.

Temperature: Lobell et al. [5] applied historical temperature-yield relationships to future California climate scenarios and concluded that table and wine grapes would be relatively unaffected by a 2°C (3.6°F) increase in temperature. In a follow-up study, they predicted that wine grapes will experience some negative effects from winter warming (Table 1). This will be partially offset by summer warming, and yield losses by 2050 probably would not exceed 5% [6]. However, higher temperatures may have negative implications for quality of wine grapes.

Changes in temperature regimes can affect grape development, such as phenolic composition, [7] and may necessitate shifts in wine grape varieties. For example, some varieties like Cabernet Sauvignon can develop undesirably low-acid fruit when cool nighttime temperatures are not reached, but shifting to Rhone varieties may diminish this impact. Hannah et al. [8] predicted that the area currently suitable for producing high-quality wine grapes may decrease by 70% under the 2050 RCP 8.5 scenario, potentially leading to increases in

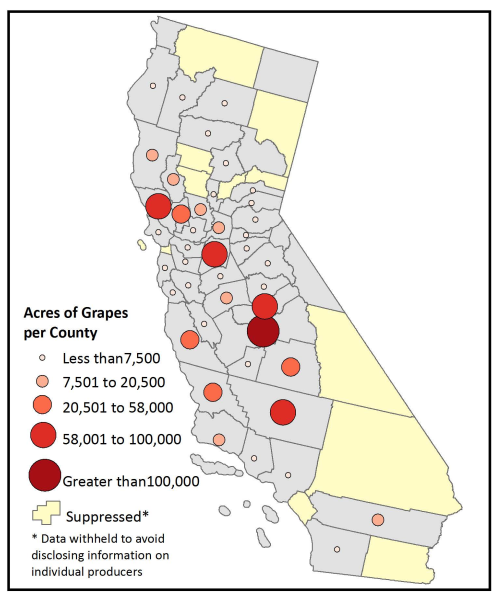

Figure 1. Acres of grapes grown in CA in 2012 (940,177 acres) [1].

freshwater demand to mist canopies and create cooler temperatures. Misting is one of a variety of management practices for climate change adaptation [9].

Table grapes may be more heat tolerant. It has been reported that table grape production has recently been established in parts of Mexico where heat units are accumulated earlier, leading to an earlier ripening and acquisition of higher prices as they are released onto the market earlier than California grapes (M.A. Walker, pers. comm.).

Water: Grapes are drought tolerant, but their vast acreage and economic importance makes optimizing water use a high priority. Further efficiency gains are possible in irrigated grapes – e.g., by transitioning table and raisin grapes from flood irrigation to drip irrigation, and better quantifying effective deficit irrigation regimes for different types of grapes in different locations. Ensuring minimal water stress during critical periods such as flowering can keep yields high even in drought conditions. However, there is a current trend in the raisin and table grape industry to gable trellis and overhead trellis systems, which may lead to increased irrigation demands (L. Williams, pers. comm., 5 January 2015). The current drought has revived interest in dry-farming grapes [10], and drought conditions may actually afford grapes a competitive advantage over other crops – e.g., Southern California avocado growers have recently been switching to grapes because grapes use one-tenth as much water per acre [11]. Water quality, specifically increasingly salinity of groundwater, is already a concern for the coastal winegrowing regions such as Paso Robles. This problem is expected to worsen in the future as sea level rise and aquifer depletion lead to saltwater intrusion.

Other factors: Impacts from increasing pest pressure have been predicted for California grapes, including pests such as the grape mealybug (*Pseudococcus maritimus*) and the vine mealybug (*Planococcus ficus*) that serve as vectors for leafroll virus [12]. Higher temperatures could lead to increases in vine mealybug densities across all regions of California, especially in the Northern regions. Increasing temperature also decreases the capabilities of existing biological control agents for vine mealybug [13]. While transitioning to more climate-tolerant varieties is an adaptation option, breeding desirable traits to augment the available scion and rootstock material represents another avenue for adaptation. Desirable traits found in *Vitis* species that could be introgressed into existing grape varieties include resistance to disease pressure from *Phylloxera*, Pierce's disease, and root-knot nematodes; and drought and salinity tolerance [14].

Table 1. Vulnerability of grapes to climate change in California.

Exposure	Sensitivity	Adaptive Capacity
• Temperature: moderate (California coast may see 2°C (3.6°F) rise, Central Valley 2.5°C (4.5°F) rise by 2060). • Water: Decreased quality and quantity likely. • Other factors: changes in pest and disease pressure.	• Grape yields are moderately sensitive to temperature, but grape quality (flavor development and sensory characteristics) can be highly sensitive. • Grape yields are moderately sensitive to water limitations; grape quality can be improved by limited water.	• Temperature: likely moderate adaptability. Key tools are variety selection, especially for wine grapes, and genetic improvement for disease resistance. • Water: high adaptability. Improve genetics for drought tolerance, improve rootstock tolerance to poor water quality, and use water strategically during critical growth periods.

References

1. National Agricultural Statistics Service, *2012 Agricultural Census*. 2014, US Department of Agriculture: Washington, DC.
2. National Agricultural Statistics Service, *California Agricultural Statistics: 2012 Crop Year*. 2013, United States Department of Agriculture: Sacramento, CA. p. 100.
3. California Department of Food and Agriculture, *California Grape Acreage Report: 2013 Crop*. 2014: Sacramento, CA. p. 63.
4. Williams, L.E., *Irrigation of winegrapes in California.* Practical Winery and Vineyard Journal, 2001(Nov-Dec 2001).
5. Lobell, D.B., et al., *Impacts of future climate change on California perennial crop yields: Model projections with climate and crop uncertainties.* Agricultural and Forest Meteorology, 2006. **141**(2-4): p. 208-218.
6. Lobell, D. and C. Field, *California perennial crops in a changing climate.* Climatic Change, 2011. **109**(1): p. 317-333.
7. Nicholas, K.A., et al., *Effect of vineyard-scale climate variability on Pinot noir phenolic composition.* Agricultural and Forest Meteorology, 2011. **151**(12): p. 1556-1567.
8. Hannah, L., et al., *Climate change, wine, and conservation.* Proceedings of the National Academy of Sciences, 2013. **110**(17): p. 6907-6912.
9. Battany, M., *Climate change in California: Vineyard cultural practices*, in *CDFA Climate Change Consortium*. 2012: Modesto, CA. p. 17.
10. Pierson, D., *Drought revives 'forgotten art' at wineries: Farming without irrigation*, in *Los Angeles Times*. 2014: Los Angeles, CA.
11. Cabrera, M., M. Cavanaugh, and N. Will, *California Drought Forces Farmers To Adapt*, in *KPBS Radio*. 2014: San Diego, CA.
12. Golino, D.A., et al., *Leafroll disease is spreading rapidly in a Napa Valley vineyard.* California Agriculture, 2008. **62**(4): p. 156-160.
13. Gutierrez, A.P., et al., *Prospective evaluation of the biological control of vine mealybug: refuge effects and climate.* Journal of Applied Ecology, 2008. **45**(2): p. 524-536.
14. Walker, M.A., et al., *Breeding Grape Rootstocks for Resistance to Phylloxera and Nematodes - It's Not Always Easy.* Vi International Phylloxera Sypmposium, 2014. **1045**: p. 89-97.

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