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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

Walnuts

Juglans regia (Juglandaceae)


Photo: USDA ARS

Walnuts are likely native to Iran, but their origin is obscured by the fact that they have been cultivated for millennia. They are in the same family as pecans (Juglandaceae). The English walnut (*Juglans regia*) is grown throughout California, which produces 99% of the walnuts in the U.S. Production is concentrated in the Sacramento and San Joaquin Valleys, but walnuts are also grown in Lake, San Benito, Contra Costa, and several coastal counties. Just two walnut varieties, Chandler and Hartley, account for 60% of California production [2] (Figure 1).

Walnuts prefer a temperate climate; the structure of young trees can be severely damaged by cold winters and flowers and young nuts can be injured by spring frosts. Walnuts are wind-pollinated, and to maximize the success of wind pollination, several different varieties should be planted in close proximity in the same orchard [3].

English walnuts are usually grafted to improve vigor and disease resistance; two common rootstocks are NCB (the Northern California black walnut, *J. hindsii*) and the hybrid 'Paradox' (*J. hindsii* × *J. regia*). However, Paradox rootstock is susceptible to crown gall (caused by *Agrobacterium tumefaciens*), while NCB rootstock is susceptible to Phytophthora root rot, and both are susceptible to the viral disease blackline. For this reason, some California walnut growers in blackline-affected areas use non-grafted English walnuts.

Temperature: The fact that walnuts have relatively high chilling requirements (800-1000 hours) warrants concern, especially because no low-chill cultivars are currently available [4] (Table 1). According to projections by Luedeling et al. [5], by the year 2060, there will no longer be a significant amount of acreage in the Central Valley that reliably receives above 800 chill-hours per year. Predicted reductions in chill-hours may also diminish walnut seed germination rates, which is important for the walnut nursery industry (15,720 acres in 2013, a 40% increase from 2012) [6].

Walnuts respond negatively to unusually warm temperatures during their dormancy period from November to February [7]. Walnuts are also sensitive to damage incurred during extreme heat events during the fruit-set period [8]. Under increased warming of 2°C (3.6°F), California walnut production could continue in some of its current range, but increased warming of 4°C (7.2°F) would completely eradicate current walnut production areas [9].

Water: Walnuts usually require 41-44 inches of irrigation water per year, comparable to other nut trees. Deficit irrigation can reduce this by about 12 inches, though yields will suffer [10]. Unlike almond and pistachio acreage, walnut acreage is expanding relatively slowly. Although walnuts have similar irrigation demands to pistachios and almonds, their total statewide water demand will probably increase more slowly than other nut crops.

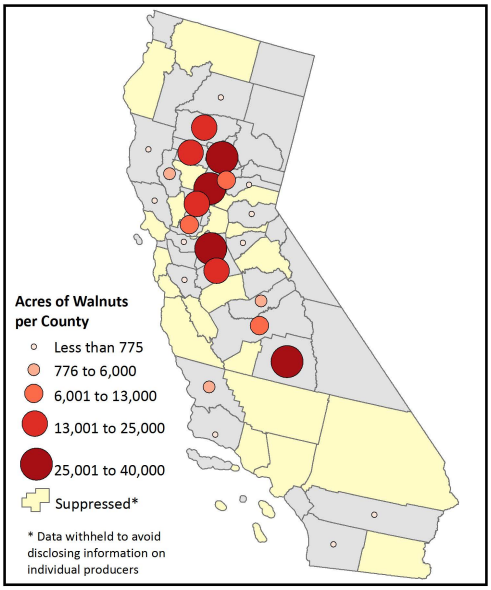

Figure 1. Acres of walnuts grown in CA in 2012 (270,000 acres). [1]

Other factors: Walnuts are vulnerable to a variety of diseases, especially under conditions of high humidity and waterlogged soils. For example, walnut blight (*Xanthomonas juglandis*) is a nut and foliage disease common in wet and humid spring conditions. Climate change in California may increase the number of heavy precipitation events, thereby increasing the disease burden of walnuts. Higher temperatures may also favor some walnut pests, such as codling moth (*Cydia pomonella*), which can increase from two to three or even four generations per year if fall temperatures are warm enough [11].

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

Exposure	Sensitivity	Adaptive Capacity
• Temperature: Moderate change (Central Valley likely to see 2-3°C (3.6-5.4°F) rise by 2060). • Water: Decreased water availability very likely. • Extreme events: heat waves, fewer frosts, large storms.	• High demand for chill hours; high sensitivity to loss of chill-hours (if below threshold). • Sensitive to water limitation: Irrigation-dependent, and do not generally fare well under deficit irrigation. • Moderately sensitive to heat stress; may benefit from less frost. Excess water can promote disease.	• Temperature: Unknown, but possibly moderate to high if low-chill cultivars can be developed. May benefit from fewer frosts. • Water: low to moderate. There is limited scope for further efficiency gains in irrigation. • Pests and diseases: Unknown.

References

1. National Agricultural Statistics Service, *2012 Agricultural Census*. 2014, US Department of Agriculture: Washington, DC.
2. Starrs, P.F. and P. Goin, *Field Guide to California Agriculture.* 2010, Berkeley, CA: University of California Press. 475.
3. UC Davis. *Walnuts*. 2014 September 1, 2014 December 13, 2014]; Available from: http://fruitandnuteducation.ucdavis.edu/education/fruitnutproduction/Walnut/.
4. Pope, K.S., *Climate Change Adaptation: Temperate Perennial Crops*, in *CDFA Climate Change Consortium*. 2012: Modesto, CA. p. 34.
5. Luedeling, E., M. Zhang, and E.H. Girvetz, *Climatic Changes Lead to Declining Winter Chill for Fruit and Nut Trees in California during 1950–2099.* PLoS ONE, 2009. **4**(7): p. e6166.
6. California Department of Food and Agriculture, *2013 Walnut Nursery Sales Report*. 2014, USDA National Agricultural Statistics Service: Sacramento, CA. p. 2.
7. Lobell, D., K.N. Cahill, and C.B. Field, *Historical effects of temperature and precipitation on California crop yields.* Climatic Change, 2007. **81**: p. 187–203.
8. Baldocchi, D. and S. Wong, *Accumulated winter chill is decreasing in the fruit growing regions of California.* Climatic Change, 2008. **87**(1): p. 153-166.
9. 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.
10. UC ANR. *Crop Irrigation Strategies: Individual Crop Deficit Irrigation Information*. 2014 December 13, 2014]; Available from: http://ucmanagedrought.ucdavis.edu/Agriculture/Crop_Irrigation_Strategies/.
11. UC Davis. *UC Pest Management Guidelines for Walnuts: Codling Moth*. 2013 January 23, 2015]; Available from: http://www.ipm.ucdavis.edu/PMG/r881300211.html.

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