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Southwest Regional Climate Hub and California Sub Hub
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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

Avocados

Persea americana (Lauraceae)


Photo: USDA ARS

The avocado is a subtropical evergreen native to the cloud forests of Central America [2]. California began producing avocados commercially in 1910 [3]. About 92% of the nation's avocados are now grown in California [4] (Figure 1), and the vast majority (95%) are Hass variety.

The native climate of avocados is wet year-round (25 to 60 inches of annual rainfall, instead of 10-15 inches in Southern California). Thus, California avocados require about 36 to 40 inches of irrigation water per year [5].

Furthermore, because the root system of avocados is about 18 inches deep [2], irrigation must be frequent and constant to prevent water stress. It takes about 74 gallons of water to grow one pound of avocados – compared to 42 gallons for one pound of peaches or 12 gallons for oranges [6].

Unlike stone fruit and nut crops, which require a certain number of chill-hours to yield well, avocados do poorly in cold weather. Freezing temperatures may kill them outright. Thus, avocado production is concentrated in Southern California (Figure 1).

Avocados have some inherent production challenges. Their delicate skin and flesh requires them to be hand-picked. They have a relatively light pest and disease burden compared to other tree crops, in part because of their recent arrival in California and its difference in climate compared to their native climate [3]. One of the most serious diseases is root rot, which is caused by *Phytophthora cinnamomi*, a pathogen similar to the one that causes Sudden Oak Death; this tends to occur with waterlogged soil.

Temperature: A study by Lobell et al. [7] reached a dire conclusion: in the absence of adaptation, avocado yields in California will decrease 45% by the year 2060. This prediction was made with a model that related avocado yield to several different temperature metrics that were based on historical observations. In this statistical model, warm temperatures in August were highly detrimental to avocado yield the following year. The biological mechanism is not fully understood [8]. To complicate matters, warm nighttime temperatures in May appeared to *boost* avocado yields, so the net effect would depend on the temporal pattern of the warming [8].

Lobell et al. [7] also predicted that avocado production will shift from coastal and inland Southern California to coastal Central California (e.g., Santa Barbara County). They postulate that with a 4°C (7.2°F) temperature rise, there will be almost no overlap between current and future avocado-growing areas.

Water: Water could be the single most important issue for California avocado growers under future climate. The current severe drought has already seen the loss of over 14,000 avocado trees in Southern California [9]. In the future, higher temperatures will exacerbate the effects of drought even further. Avocados' total water use is not likely to increase – in fact, avocado acreage in California has declined in the past decade [10] – but simply maintaining the current acreage will be a challenge.

Avocados are inherently very sensitive to excessive salinity, which can occur due to insufficient or poor-quality irrigation water [5]. As water supply and quality are both expected to decrease, salinity is likely to become an ever greater concern for avocado growers (Table 1).

Research on deficit irrigation in avocados is sparse, but given avocados' high sensitivity to drought – for example, one week of missed irrigation can cause complete failure of the subsequent crop – it will be challenging to come up with a deficit irrigation strategy that does not harm yields. Less risky ways to reduce water use include repairing leaky pipes, frequently measuring soil moisture or other metrics of water availability; preventing runoff by accounting for the orchard's slope and infiltration rate; and removing old or unproductive trees [11].

Other factors: Avocados do stand to benefit from one aspect of climate change: the reduced probability of freezing temperatures. Stand losses from frost damage are likely to become much less common, even as other stressors become more prevalent. Avocados are wind-pollinated, so climate impacts on pollinators will not affect them [3]. It is unknown how rainfall patterns may change in avocado growing seasons, so it is hard to say whether the incidence of waterlogging-induced diseases such as root rot will increase or decrease.

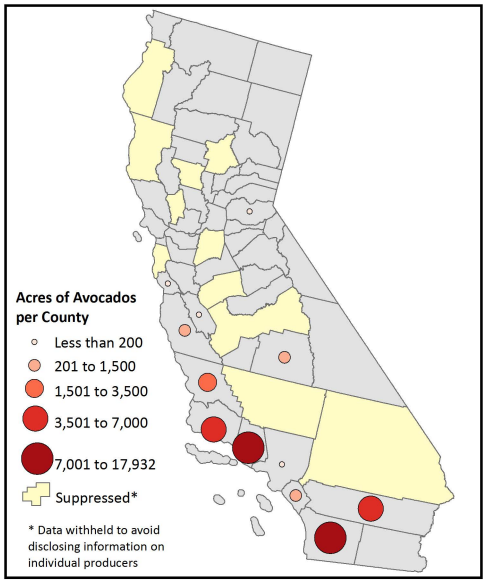

Figure 1. Acres of avocados grown in CA in 2012 (59,814 acres) [1].

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

Exposure	Sensitivity	Adaptive Capacity
• Temperature: moderate to high exposure (southern coast may see 2°C (3.6°F) rise and southern inland 3°C (5.4°F) rise by 2060). • Water: Decreased water quality and quantity very likely. • Extreme events: More heat waves, fewer freezes.	• Moderate to high sensitivity to warm summer temperatures (but can benefit from warm spring). • High sensitivity to water limitations. Water requirements high and inflexible. Irrigation-dependent. • Not very sensitive to changes in diseases, pollinators, and pests.	• Temperature: Unknown, but probably moderate to low capacity. A shift in production areas may be necessary. • Water: probably low. Avocados are not adapted to aridity and do not fare well under deficit irrigation.

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Published 2016

California Sub Hub
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