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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

Carrots

Daucus carota (Apiaceae / Umbelliferae)

Carrots are native to Central Asia and are in the same family as parsley and celery. California is the top carrot producer in the nation, accounting for 66% of the total crop [1] . Carrots are grown in many parts of California, including the Central Coast, the San Joaquin Valley, the southern desert, and the high desert of Los Angeles County (Figure 1). In each of these four regions, carrots are planted and harvested according to a different schedule, with the result that California's total carrot production is fairly steady year-round [3].

Carrots are a cool-season crop, though they will tolerate warm temperatures in their establishment phase. Temperatures of 15.6-21.1°C (60-70°F) are optimal for growth rate, flavor, and color; temperatures below 10°C (50°F) tend to retard growth, and temperatures above 30°C (86°F) can cause the root to develop a strong and unpleasant flavor [3].

Over the course of their 100-120 day growing season, California carrots require about 24-30 inches of irrigation water (J. Nuñez, pers. comm., 23 December 2014), with up to 40 inches sometimes applied in the arid Imperial Valley (T. Hartz, pers. comm., 22 December 2014). The manner and timing of carrot irrigation is crucial. Carrot roots are most marketable when grown on sandy or loamy soils with constant, moderate irrigation via sprinklers or central-pivot systems; drip irrigation does not produce sufficiently uniform moisture [3]. If irrigation is insufficient during the germination and seedling stage, crooked and forked carrot roots may result. Water stress during the carbohydrate accumulation phase may cause woody, cracked, and bitter roots [4], and temperature stress during this phase may cause the root to lose its color [1].

Carrot fields are susceptible to weed invasion (especially by nutsedge, *Cyperus* sp.). Although not as disease-prone as some annual crops, carrots have a long list of possible ills, many of which are favored by warm and moist conditions (e.g., bacterial soft rot, alternaria leaf blight, southern blight, and powdery mildew, among others).

Temperature: Little research exists on how rising temperatures may affect carrot production; no California-specific studies could be found at the time of writing. We speculate that carrot producers may be able to at least partly avoid negative impacts of high temperatures via adjustments in planting time and/or location. The diversity of carrot growing sites around California will likely be an asset for future adaptation efforts. Some carrots are already grown in areas (e.g., southern San Joaquin Valley) where daytime temperatures can exceed 32.2°C (90°F) during harvest (T. Hartz, pers. comm., 22 December 2014); carrot varieties that thrive in these locations may prove useful beyond their current range.

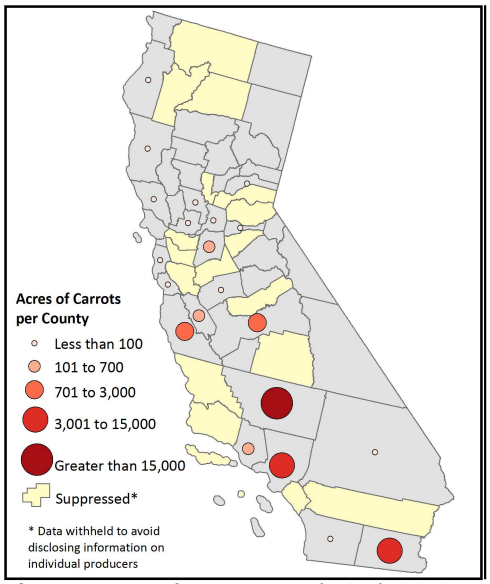

Figure 1. Acres of carrots grown in CA in 2012 (65,400 acres) [2].

Water: Carrots are vulnerable to disruptions in water quality or quantity (Table 1). Salinity is a particular problem for them [5]. As climate change is expected to exacerbate these challenges, it will be helpful to anticipate the possible water-related impacts of climate change on carrot production and plan accordingly. Limited water will probably present a greater problem for carrots than higher temperatures.

Other factors: Carrots are not particularly vulnerable to storm damage, freezing, or flooding, but they may be affected by climate-mediated changes in pests, pathogens, and weed populations.

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

Exposure	Sensitivity	Adaptive Capacity
• Temperature: exposure depends on location (California coast may see 2°C rise, inland deserts 3°C (5.4°F) rise by 2060). • Water: Depends on location, but decreased quality and quantity likely.	• Can benefit from slightly warmer winters, but can be harmed by high temperatures, especially if above 32.2°C (90°F). • Moderate to high sensitivity to water limitations. Irrigation-dependent and salt-sensitive.	• Temperature: likely moderate adaptability. Adjusting timing of planting and harvest may help avoid heat. • Water: likely low adaptability, as carrots cannot use drip irrigation and need frequent ample irrigation throughout their growth cycle.

References

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