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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

Strawberries

Fragaria × *ananassa* (Rosaceae)


Photo: USDA NRCS

Strawberries are California's most valuable annual crop: more than $2B annually, accounting for about 90% of U.S. production [1]. This may seem surprising when strawberries are only grown on 39,000 acres – almost exclusively in the coastal areas of central and Southern California (Figure 1). The apparent mismatch between value and acreage is because strawberries have the highest value per acre of any of California's major specialty crops (by nearly a factor of ten).

Strawberries are expensive and difficult to grow and harvest. They are highly vulnerable to soil-borne fungal diseases such as Fusarium wilt and Verticillium wilt, and so (despite being a perennial plant) they are replanted every year to allow the soil to be thoroughly fumigated. Even organic strawberry growers usually obtain their seedlings from non-organic nurseries. Fragile and perishable, strawberries must be hand-picked and transported in refrigerated trucks.

All strawberries in California are irrigated, almost exclusively using drip irrigation underneath plastic mulching; this reduces disease by keeping moisture away from the foliage [3]. Irrigation varies from about 10 to 40 inches per year, with an average of 21 inches [4]. Strawberries are highly sensitive to salinity, which means that they may require water in excess of their evaporative demand for the sake of leaching salts from the soil (Table 1).

Strawberries prefer a cool coastal climate, which is one main reason that California's strawberry fields are much more productive than those elsewhere in the country [3]. Unusually warm temperatures can not only shorten the growing cycle, they can promote pests and diseases, such as mites, fruit rot, corn earworms, and caterpillars.

Temperature: Lobell et al. [5] used historical climate and crop data to model the effect of temperature on strawberry yields in California. They concluded that strawberry production was favored by cool, wet Novembers and moderately warm, dry springs, in accordance with what growers had reported qualitatively. The current level of uncertainty in downscaled climate projections for California makes it difficult to say whether these precise conditions will become more or less likely in the future.

In a follow-up study, Lobell and Field [6] predicted that climate change would decrease yields of California strawberries by about 10% by 2050, with impacts somewhat greater in the southern part of the state. However, Deschenes and Kolstad [7] predict that strawberry yields would decline by 43% by 2070-2099. Further statistical modeling could help increase the accuracy and specificity of these predictions. Nevertheless, it seems clear that warmer temperatures will very likely harm statewide strawberry production in coming decades.

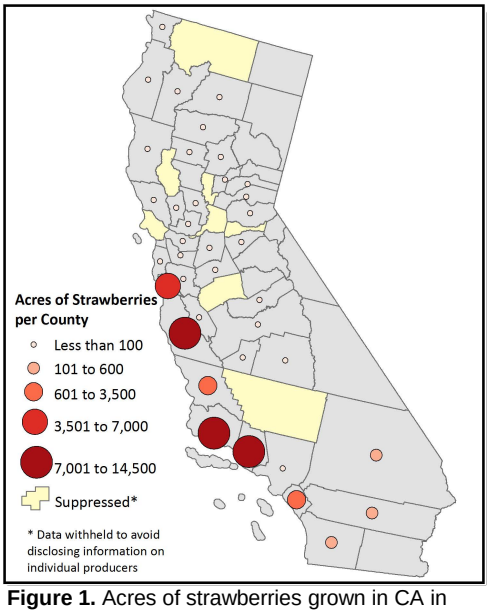

Figure 1. Acres of strawberries grown in CA in 2012 (39,000 acres). [2]

Water: Water quality and quantity is already a major concern for California strawberry growers [8], and will become even more of a concern under future climate. The water demand of strawberries is not particularly high (when grown in cool climates with efficient drip irrigation and plastic mulching), but the water supply is often problematic. In the coastal areas where strawberries are grown, groundwater salinity is exacerbated due to sea level rise and excessive withdrawals resulting in saltwater intrusion. Salt tolerance breeding in strawberries may enhance adaptive capacity.

Other factors: Because strawberries suffer from such intense pest and disease pressure, it will be important to understand how climate change might affect these pressures. Some strawberry diseases are promoted by high temperatures, others by low temperatures, and many diseases are exacerbated by humidity [3]. In particular, warm dry weather accelerates mite infestations but reduces grey mold, while warm weather in general promotes powdery mildew (O. Daugovish, pers. comm., 7 January 2015).

The Salinas Valley, a major strawberry-growing region, is sometimes affected by flooding; for example, when the Salinas River overflowed in 1995, the resulting damage to strawberry, lettuce, and broccoli crops made it the third most costly weather event for California agriculture in the past 30 years [9]. Floods may become more frequent or intense due to the more intense precipitation expected with climate change.

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

Exposure	Sensitivity	Adaptive Capacity
• Temperature: low to moderate exposure (California coast may see 2°C (3.6°F) rise by 2060; changing fog patterns may exacerbate warming effect). • Water: Decreased water quality and quantity likely; saline groundwater due to saltwater intrusion (no water project deliveries in coastal areas). • Extreme events: more flooding possible.	• Moderate sensitivity to warm fall and winter temperatures (but can benefit from warm, dry spring). • Moderate to high sensitivity to water limitations. Irrigation-dependent and easily harmed by poor water quality. • These sensitivities may be reduced or amplified due to changes in pest and pathogens.	• Temperature: Unknown. May need to employ cultivars adapted for warmer climates. Shifts in growing areas and/or planting times may be needed. • Water: probably low to moderate. Further improvements in irrigation efficiency are possible, but salinity becomes more problematic. • Pests and diseases: Unknown.

References

1. Starrs, P.F. and P. Goin, *Field Guide to California Agriculture*. 2010, Berkeley, CA: University of California Press. 475.
2. National Agricultural Statistics Service, *2012 Agricultural Census*. 2014, US Department of Agriculture: Washington, DC.
3. California Strawberry Commission, *Crop Profile for Strawberries in California*. 1999, University of California Division of Agriculture and Natural Resources. p. 72.
4. Cahn, M., *Irrigation management of strawberries*, University of California Division of Agriculture and Natural Resources, Editor. 2011.
5. 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.
6. Lobell, D. and C. Field, *California perennial crops in a changing climate.* Climatic Change, 2011. **109**(1): p. 317-333.
7. Deschenes, O. and C. Kolstad, *Economic impacts of climate change on California agriculture.* Climatic Change, 2011. **109**(1): p. 365-386.
8. Paddock, E., *Driscoll's Water Commitment: Pajaro Valley Groundwater Basin*, in *CDFA Climate Change Consortium*. 2013: Sacramento, CA. p. 14.
9. Lobell, D.B., A. Torney, and C.B. Field, *Climate extremes in California agriculture.* Climatic Change, 2011. **109**: p. 355-363.

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