

# California Agriculture & Climate Change

## Understanding Climate Change Impacts



Dependent on weather and the availability of natural resources, California agriculture is uniquely vulnerable to climate change. Rising temperatures, constrained water resources, and increased pest and disease pressure are among the climate change impacts that threaten to fundamentally challenge California agriculture in the coming years and decades<sup>1</sup>. To keep California agriculture viable, significant investments in research, technical assistance and financial incentives will be needed to assist agriculture in adapting to climate change.

Here we provide a brief review of the latest science on climate change and its potential impacts on California agriculture.

### Changing Water Patterns and Supply

Changing precipitation patterns will likely significantly affect water availability in California. As temperatures warm, precipitation will increasingly fall in the form of rain rather than snow during the winter months<sup>2</sup>. As a result, the Sierra Nevada snowpack — the state's primary water storage — will be lower than historical levels, resulting in likely reductions in runoff, shifts in timing and season of water release and subsequently decreased water supply. Some research has suggested that snowmelt runoff could occur up to two months earlier than current averages<sup>3</sup>.

Warmer temperatures will allow for longer growing seasons in the near term, which will consequently increase water requirements for crops<sup>4</sup> at a time when water supply reliability is decreased<sup>5</sup>. Reduced runoff in late spring and early summer during peak planting season will also increase demand for irrigation<sup>6</sup> and likely lead to heightened competition between urban, agricultural and environmental uses<sup>7</sup>. Constrained water resources will be among the most challenging effects of climate change for California agriculture.

### Reduced Winter Chill Hours

Warming temperatures are threatening some of the state's most lucrative sectors of the agricultural economy. Proper setting of fruit requires between 200 and 1200 winter chill hours a season, during which time temperatures drop below 45 degrees F in California. Chill hours have been decreasing since the 1950s and predictions are that by the end of the century up to two-thirds of chill hours will be lost in parts of the Central Valley, the state's primary fruit and nut tree growing region. Crops such as apples, cherries or pears that require long chill hours may have extremely limited growing ranges by 2050<sup>8</sup>. A number of perennial crops in the state may be particularly hard hit, including avocados, nuts<sup>9</sup>, grapes<sup>10</sup>, and stone fruit<sup>11</sup>. Though warmer nights have positively impacted oranges<sup>12</sup> and wine grapes in some cases<sup>13</sup>, continued warming will create conditions unfavorable for production of many wine grape varieties in the future<sup>14</sup>.

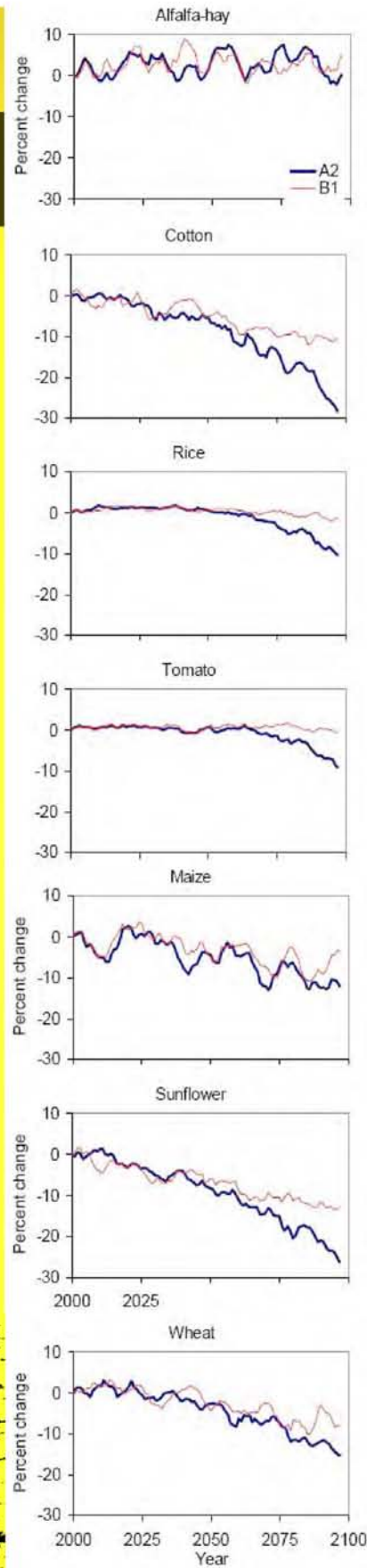
Continued production of many of these fruits will require farmers changing the cultivars they plant, or moving production further north and/or "upslope" to higher elevations. Each of these scenarios presents their own challenges, including increased costs of production.



# Decreased Crop Yields

Warmer temperatures will likely extend the growing season and increase crop yields in the near term, but such benefits will be limited. Longer growing seasons will put additional pressure on resource use and new evidence suggests that many crops may face yield losses in the long term. The U.S. Climate Change Science Program noted that annual crops including rice, corn and sorghum will likely have notable decreases in crop yields in the coming decades<sup>15</sup>. Temperature increases may also negatively affect tomato yields<sup>16</sup>. Current U.S. growing regions for corn, soybeans and cotton may have yield decreases of 30-46 percent by the end of the century under the slowest predicted warming scenario and a decrease by 63-82 percent under the most rapid warming scenario<sup>17</sup>.

As described in Figure 1, California climate models suggest that even the slowest warming scenarios (scenario B1) will have an effect on crop yields for a variety of annual plants. Cotton, maize, sunflower, and wheat yields may decrease an average of three to eight percent by 2050. Cotton and sunflower will face even greater yield losses as soon as 2025 and by the end of the century may decrease as much as 29 percent<sup>18</sup>.



# Extreme Weather Events



Climate change has the potential to increase the number and intensity of extreme weather events in the state<sup>25</sup>, which may have profound short-term impacts on agriculture. Flooding in the Delta and Central Valley farmland is likely to increase from the combination of rapid snow melt resulting from warmer temperatures in the Sierra Nevada and increased winter and spring rainfall<sup>26</sup>.

The magnitude and persistence of droughts are also expected to increase, with some climate models suggesting increased moderate droughts in the state and other models suggesting less frequent but more severe droughts<sup>27</sup>.

Extreme temperatures may further exacerbate difficult agricultural conditions. Vulnerabilities to heat particularly for flowering crops may negatively affect growth. Existing research suggests that tomatoes suffer losses as a result of extreme temperature events including heat waves and late frosts. Heat waves may also place additional demands on water and irrigation, further restricting available supplies<sup>28</sup>.

**Figure 1. Two warming scenarios modeling crop yields, shown in 25-year increments (2000, 2025, 2050, 2075, 2100)**

Source: CA Dept. of Natural Resources. 2009 California Climate Adaptation Strategy. p. 94.

# Vulnerabilities of Livestock Agriculture

Livestock agriculture in California is a significant portion of the agricultural economy. California is the top dairy producing state in the nation. Cattle/calves and chickens are among the largest commodities in the state, contributing nearly \$11 billion annually<sup>22</sup>.

Livestock production may be heavily affected by changes in climate as a result of increased pests and diseases. Elevated temperatures could increase the persistence and dispersal of animal pathogens<sup>23</sup>. Warmer temperatures can cause increases in mortality and/or decreases in productivity as a result of physiological stress and lower feed consumption. In the context of feedlots, higher temperatures will likely increase the production of methane, ammonia and other gasses associated with ruminants. Moreover, increased heat waves and rising temperatures will likely lead to overall reductions in meat, egg and dairy production as well as the reproductive capability of livestock<sup>24</sup>.

## Weeds, Pests and Disease

Although increases in carbon dioxide, the primary driver of global warming, may increase plant growth, weed and pest populations are also predicted to increase<sup>19</sup>. Crops grown at elevated carbon dioxide levels have up to twice as many insects and increased levels of insect damage compared to control groups<sup>20</sup>. Warmer temperatures will likely lead to the northern migration of invasive species and weeds.

As weed growth intensifies, herbicide use may also increase. Research predicts that glyphosate, the most widely used herbicide in the United States, will continue to lose efficacy as its overuse results in herbicide resistance in more weed species. In response, some growers may increase the volume, types and potency of herbicide applications in the future, which may add to production expenses and exacerbate pesticide pollution problems<sup>21</sup>.

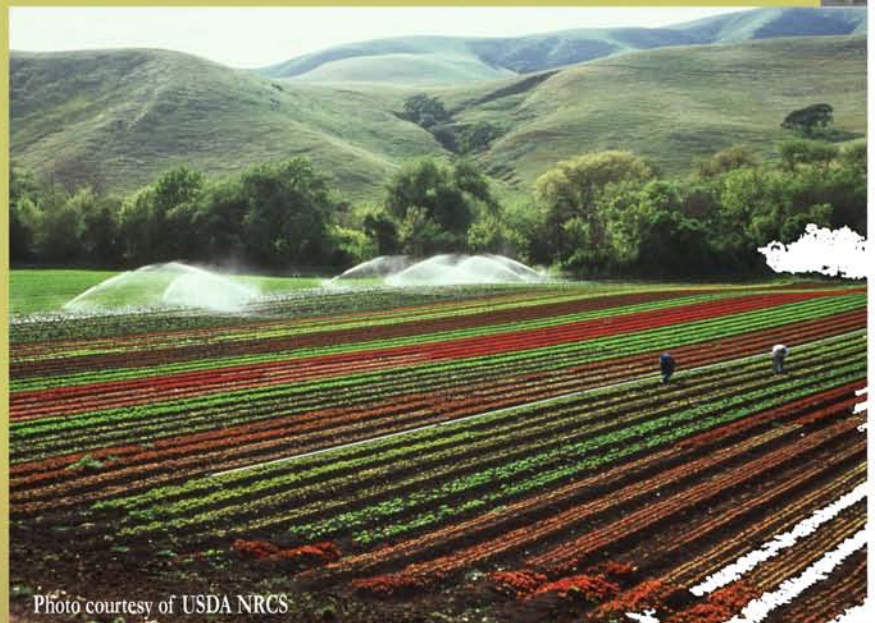


Photo courtesy of USDA NRCS



## Economic Impacts

All of the changes summarized above have economic implications and widespread consequences. Agricultural products are an important contribution to the state's economy, resulting in nearly \$37 billion a year for its 75,000 farms and ranches. On average, the agricultural sector in California provides nearly 400,000 jobs directly employed in farming<sup>29</sup>, with many more jobs dependent on the agricultural industry. While estimating the full economic impact of climate change on California agriculture is just beginning, early estimates demonstrate significant impacts.

Agriculture is one of the most vulnerable sectors to water shortages and annual costs of nearly \$200 million could be incurred by agriculture if water availability is reduced by 20 percent below current demand levels<sup>30</sup>. Decreased water availability could produce losses of up to \$1,700 an acre<sup>31</sup>.

## Preparing for Climate Change



Photo courtesy of USDA NRCS

California is already experiencing the effects of climate change, including warming temperatures, a rise in sea levels, longer fire seasons and shifts in precipitation<sup>32</sup>. Efforts to reduce greenhouse gas emissions and avoid the worst effects of climate change are needed, but they will not be enough to avoid all of impacts of climate change. California agriculture will have to adapt to a changing climate and resources will be needed to make that possible.

Additional research, specific to California, can assist scientists and agricultural producers to understand the management options available to them to adapt to climate change. Technical assistance and financial incentives will translate research findings and support a broad base of California producers in making transitions. Investments must be made, using innovative policies and funding at the state and federal level, to ensure that agriculture contributes to climate protection efforts and remains a diverse and vibrant contributor to the economy and culture of California.

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