Potential Impacts in the Agricultural Sector

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Agricultural assessments

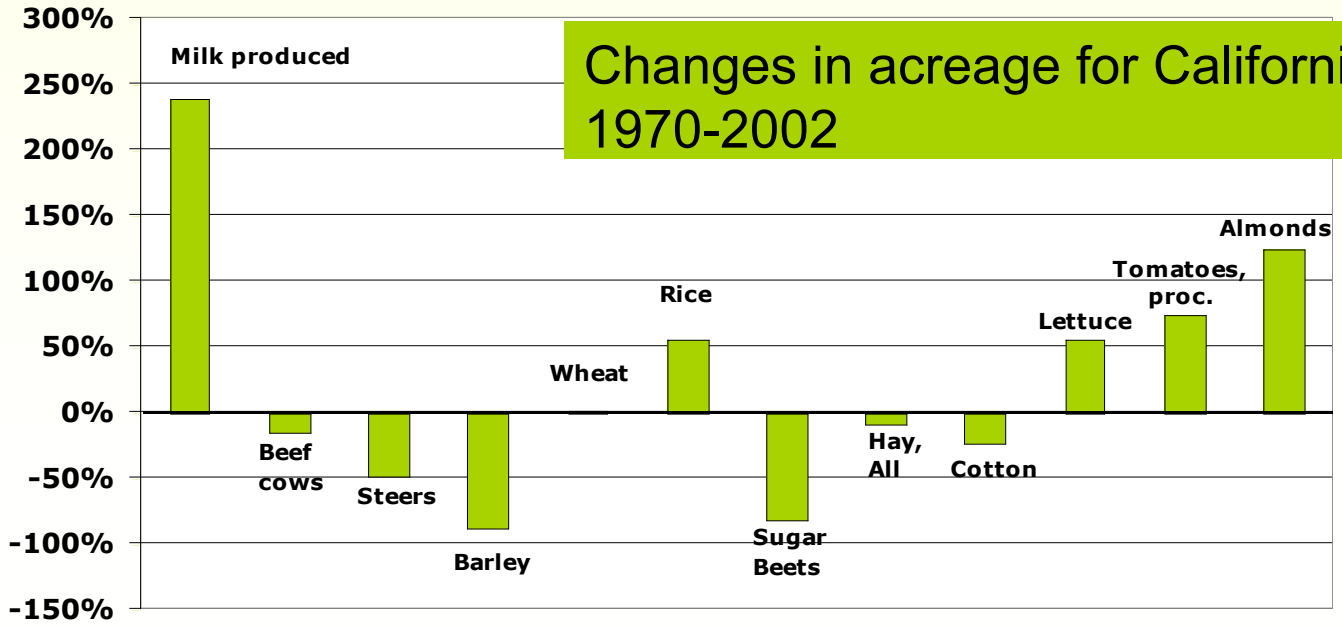
- Review (Cavagnaro, Jackson, and Scow)
  - UC Davis "*Climate Change Symposium: Challenges and Solutions for California Agricultural Landscape*"
- Modeling
  - Crop physiology and yield response to CO_2 and temperature (Baldocchi et al.)
  - Geographic distribution and pest control, based on physiology of pests (Gutierrez et al.)

California agriculture

- $31.8 billion in cash farm receipts
- Highly productive agriculture
  - Highest production in the USA since 1948
  - Half of the nation's fruits and vegetables and 19% of dairy
  - 14% = export
- Diverse commodities
  - 310 crop and livestock commodities
  - Top 10: milk and cream, nursery, grapes, lettuce, almonds, cattle and calves, strawberries, flowers, tomatoes
- Employment and industries
  - 7.5% of employment statewide; 25% in the Central Valley
  - >75,000 farms

Adaptability of California agriculture

- California agriculture is agile and copes with change
  - Rapid changes in acreage and production rates
  - Large shifts in geographic distribution of top counties and commodities (1900-2005)
  - Immediate response to drought in 1987-1991: groundwater use, reduced water use, less water-intensive crops, land fallowed
- High degree of technological adaptation



Changes in acreage for California commodities, 1970-2002

From:
UCD Agricultural Issues Center

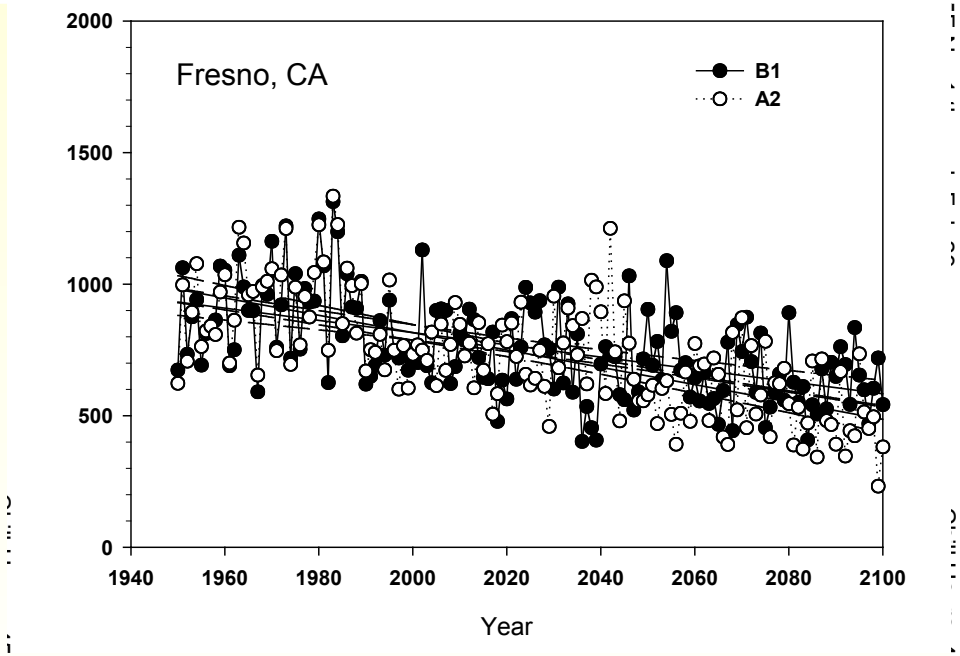
Crop responses to higher CO_2 and temperature

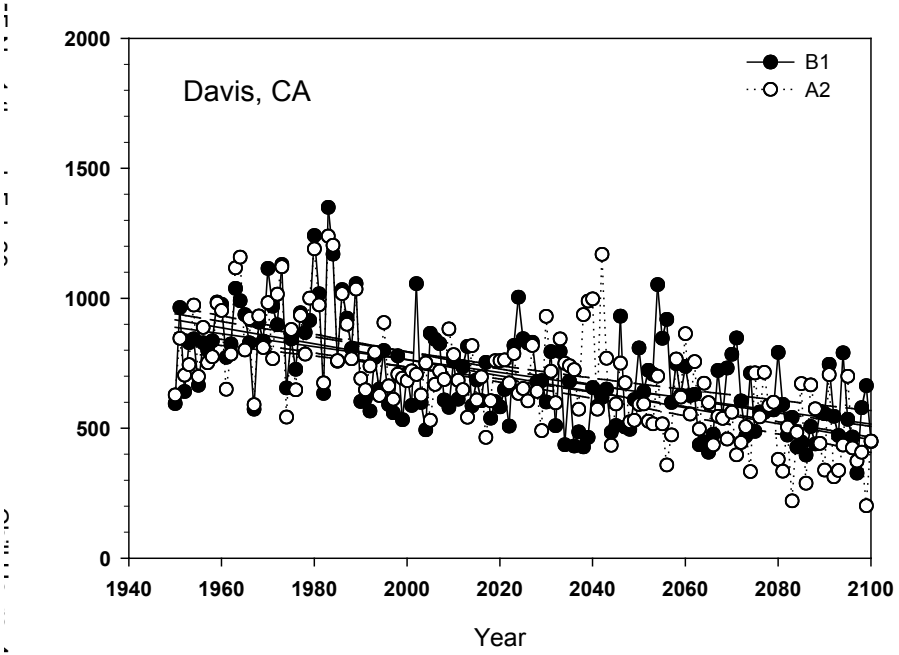
- Higher CO_2 and temperature increase vegetative growth in plants
- Crop developmental responses are much more complex
  - e.g., winter chilling for perennials has decreased
    - Chill hours/yr (<45F per year) reduced 50-500 hrs/yr
    - 200-1200 hrs required by fruit trees to flower
    - Low peach yields in 2004

Crop	Response to higher temperature (literature review)
Tomato	Reduced fruit number
Lettuce	Shortened growing season
	Increased incidence of tipburn
	Early bolting (flowering onset)
Rice	Reduced yields
	Increased spikelet sterility
Stone fruits	Decreased fruit size and quality
Citrus	Reduced frost losses and increased yields
Grapes	Premature ripening and possible quality reduction
	Increased yield variability

Chill hours projected to decrease during winter

Inadequate accumulated chill hours for fruit trees





Fruit trees such as almonds, cherries, apricots, and others may not continue to be produced in California; some of these crops account for over 90% of U.S. production.

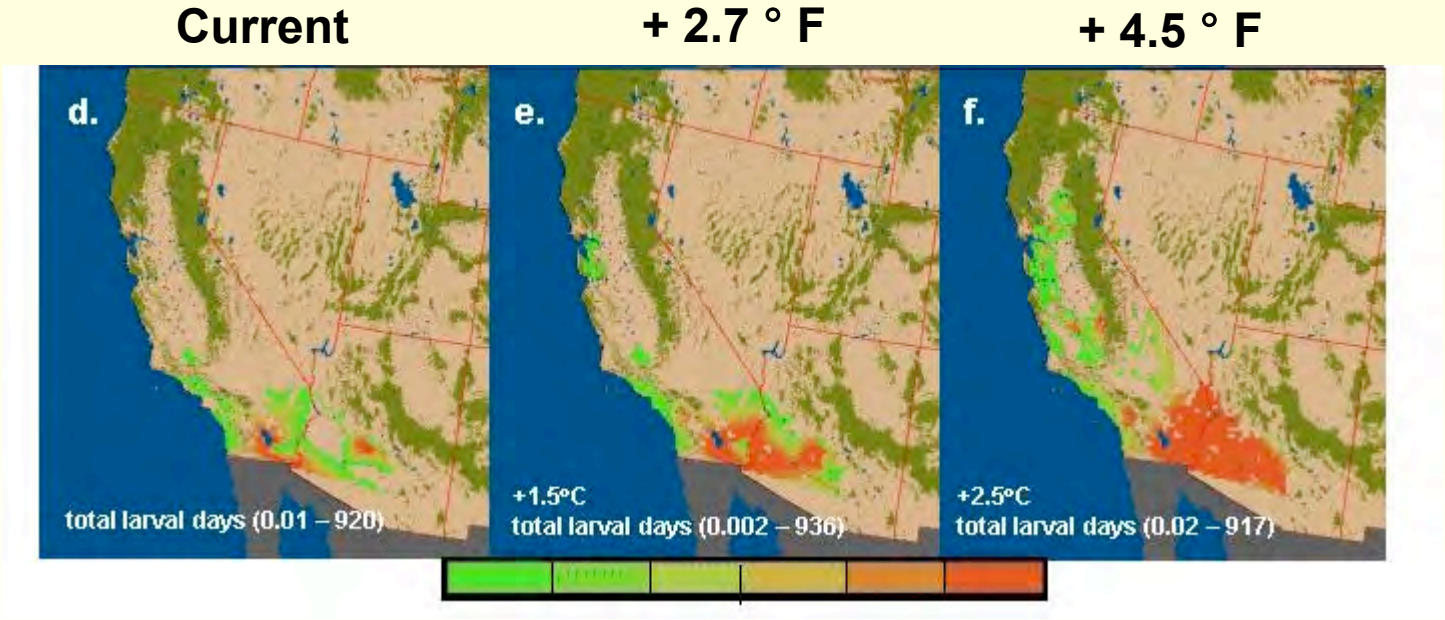
(Baldocchi et al.)

Other challenges with higher temperatures (and CO_2)

- Water use will increase; unique response for each commodity
- Ozone phytotoxicity will increase (VOCs + NO_X)
- Crop pests--unknowns
  - Diseases increase with warm/wet compared to warm/dry scenarios
  - Insect pests will survive winter, but leaf quality may be lower
  - Weeds: new C4 species
- Cattle and dairy cows

Climate projected to become more favorable for pests

Projection for Cottonwood Bollworm



Total seasonal pest PBW larval densities (larval days, d-e) under current weather (a) and with 1.5ºC (e) and 2.5ºC (f) increases in daily temperatures, respectively.

(Gutierrez et al. in press).

Potential for reducing impact on agriculture and its economic value

- Higher value commodities
- Growing crops which have lower water demand (i.e., less alfalfa, cotton, rice and irrigated pasture)
- Crop and livestock breeding for heat tolerance
- Water conservation: technological improvement
- Land use: specialty crops shift north and south; urbanization increases
- Dry climate scenarios: water scarcity causes large economic costs

Potential for agriculture to be part of the solution to reduce GHG emissions

- Sequestration of carbon by crops and soils
  - Conservation tillage, cover crops, and trees
- Reduce N_2O emissions from agricultural soils
  - Fertilization and irrigation strategies
- Reduced fuel use, e.g., for tillage, pumping of water, and transport
  - Agriculture and forestry contribute 8% of CA's GHG emissions