Climate Change and Agriculture

Amrith Gunasekara, PhD
Science Advisor to the Secretary
California Department of Food and Agriculture
http://www.cdfa.ca.gov/

April 30, 2012
CalEPA
Sacramento, CA
Agriculture and Human Population Growth

Challenges for agriculture

Fig. 2. Global food chain and human population growth (Khan and Hanjra, 2009 and references therein).

Climate Change in California

The Governor’s Conference on Extreme Climate Risks and California’s Future

Conference Home

"It's time for courage, it's time for creativity and it's time for boldness to tackle climate change."
- Governor Brown, Sept 13, 2011

View the conference on video: Part 1 | Part 2 | Part 3 | Part 4

On December 15, Governor Edmund G. Brown Jr. and environmental, business and public health and safety leaders came together at The Governor’s Conference on Extreme Climate Risks and California’s Future.

The Governor’s Conference focused on the threats of unpredictable and extreme weather events on the state’s economy, business sectors, public health and natural resources. Attendees discussed the best ways to prepare and protect our state and adapt to these growing risks.

The Governor’s Conference built on the findings of a United Nations’ Intergovernmental Panel on Climate Change (IPCC) report outlining the link between global warming, extreme weather events and their economic impact.

Through 2012, complementary events are being held throughout the state to provide for in-depth review of certain extreme weather threats and potential solutions.

http://www.climatechange.ca.gov/ecrcf/index.html
Climate Change in California

Complementary Events

November 9, 2011
Cal EMA Executive Flood Seminar

November 16, 2011
The Impact of Extreme Events and Climate Change on California’s Food Supply

December 13, 2011
Vulnerability and Adaptation to Extreme Events in California in the Context of a Changing Climate

April 9, 2012
Confronting Climate Change: A Focus on Local Government Impacts, Actions and Resources

http://www.climatechange.ca.gov/ecrcf/co_events.html
STATE BOARD OF FOOD AND AGRICULTURE TO DISCUSS EXTREME CLIMATE RISKS ON NOVEMBER 16 IN SACRAMENTO EVENT ASSOCIATED WITH GOVERNOR BROWN’S EXTREME EVENTS CONFERENCE IN DECEMBER

SACRAMENTO, November 10, 2011 - The California State Board of Food and Agriculture, in partnership with the California Department of Food and Agriculture, is hosting a forum on Extreme Climate Risks and California’s Future - Agriculture and the Food System on November 16, 2011 in Sacramento. The forum will provide an overview of the potential impact of climate change on California’s food and farming sector.

“Worldwide we have seen an increase in volatile weather events that have had significant impact on global food supplies,” said CDFA Secretary Karen Ross. “As one of the key growing regions in the United States, California must be prepared for effects of a changing climate and what this means for food production.”

The forum will be held on Wednesday, November 16, 2011 from 10:00 a.m. to 2:30 p.m. at the California Department of Food and Agriculture, 1220 N Street, Sacramento, CA 95814. A variety of speakers representing academia and federal, state and local government will address adaptation to climate change, economic impact and extreme event planning. Keynote presentations will be provided by Lucinda Roth,
Climate Change Predictions

Lucinda Roth
Climate Change Specialist
USDA NRCS

Is climate change happening?

Climate Change in California

Is it happening in California?

Challenges for Agricultural Landscapes

Extreme weather events
- Less water – water efficiency and management
- Fruit and nut crops sensitive to temp changes
- Crop pests
- Dairy cow milk production yields – heat stress
- Insufficient chill hours (below 45°)
Climate Change and Agriculture

- Insufficient chill hours (below 45°)

Chilling requirements for many tree crops need to be fulfilled each winter to ensure homogeneous flowering and fruitset, and generate economically sufficient yields (optimize yields).

Insufficient winter chill can severely reduce crop yields and crop quality.

When chilling requirements are not completely fulfilled, trees display irregular and temporally spread out flowering, leading to inhomogeneous crop development.
Climate change could put the heat on California crops

Fruit and nut orchards in the Central Valley rely on winter chilling hours, but those are in decline, according to a UC Davis study.

Only 4% of the Central Valley is now suitable for apples, cherries and pears, all high-chill fruits that could once be grown in half the valley, according to the UC Davis study.

By the end of the century, UC Davis study says, "areas where safe winter chill exists for growing walnuts, pistachios, peaches, apricots, plums and cherries are likely to almost completely disappear."
Climate Change and Agriculture

Dr. Glen MacDonald
Institute on Environment and Sustainability
UCLA

Drought


Cover Image: Pictured is an intake tower of the Hoover Dam on Lake Mead near Las Vegas, Nevada. The largest reservoir in the United States, Lake Mead is now at slightly more than one third its capacity. Since 2000, the water level in the lake has dropped by nearly 40 m. A further drop of less than 3 m would trigger a level 1 water shortage declaration for the first time in the lake’s history, potentially restricting water supply to Nevada and Arizona. See the introductory Perspective by Glen M. MacDonald on pages 21256–21262 for the Climate Change and Water in Southwestern North America Special Feature. Image courtesy of Glen M. MacDonald.
Climate Change and Agriculture

Kamyar Guivetchi
California Department of Water Resources

Water Supply
- Water Distribution in state
- Water supply in state
- Snow pack
- Heat stress on $H_2O$ supply
“Increasing temperatures are likely to change pest dynamics in California, according to all future climate scenarios analyzed.”

“Generation numbers of codling moth, navel orangeworm, web-spinning spider mites and European red mites are likely to increase, generating new challenges for pest control.”
Climate Change, Agriculture, and Public Health

We talked a lot about the following;
- Drought, Water availability, Flooding, Insurance, Chill hours
  Temperature, Invasive species, Food supply, Local level planning

We did not talk about what we here today to discuss….the important relationship between extreme events (climate change), food supply (agriculture), and nutritional availability (public health)
- Food chain, Food safety, Food production reliability, Food supply, Local level planning
Agriculture in California

- Mediterranean climate
- Some of the most fertilize agricultural soils in the world (e.g., Central Coast)
- More than half the nation’s fruits, vegetables, nuts
- Year round production in some areas
  - Lemons, artichokes, avocados, broccoli, cabbage, carrots, cauliflower, celery, lettuce, mushrooms, potatoes, spinach, squash
- The most specialty crops in the nation (99%)
  - Almonds, artichokes, figs, grapes, raisins, kiwi fruit, olives, peaches, pistachios, walnuts, plums, pomegranates
**Agriculture in California**

**Specialty Crops (USDA AMS Definition)**

“Specialty crops are defined in law as “fruits and vegetables, tree nuts, dried fruits and horticulture and nursery crops, including floriculture.”

<table>
<thead>
<tr>
<th>Fruits and Tree Nuts</th>
<th>Vegetables</th>
<th>List of Ineligible Commodities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almond</td>
<td>Artichoke</td>
<td>Alfalfa</td>
</tr>
<tr>
<td>Apple</td>
<td>Asparagus</td>
<td>Amylomaize</td>
</tr>
<tr>
<td>Apricot</td>
<td>Bean</td>
<td>Barley</td>
</tr>
<tr>
<td>Avocado</td>
<td>Snap or green</td>
<td>Buckwheat</td>
</tr>
<tr>
<td>Banana</td>
<td>Lima</td>
<td>Canola</td>
</tr>
<tr>
<td>Blackberry</td>
<td>Dry, edible</td>
<td>Canola Oil</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Beet, table</td>
<td>Clover</td>
</tr>
<tr>
<td>Breadfruit</td>
<td></td>
<td>Rye</td>
</tr>
<tr>
<td>Cacao</td>
<td></td>
<td>Cotton</td>
</tr>
<tr>
<td>Cashew</td>
<td></td>
<td>Clothseed oil</td>
</tr>
<tr>
<td>Citrus</td>
<td></td>
<td>Dairy products</td>
</tr>
<tr>
<td>Cherimoya</td>
<td></td>
<td>Bathish (marine or freshwater)</td>
</tr>
<tr>
<td>Cherry</td>
<td></td>
<td>Dent corn</td>
</tr>
<tr>
<td>Chestnut (for nuts)</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td>Coconut</td>
<td></td>
<td>Field corn</td>
</tr>
<tr>
<td>Coffee</td>
<td></td>
<td>Fish (marine or freshwater)</td>
</tr>
<tr>
<td>Cranberry</td>
<td></td>
<td>Flax</td>
</tr>
<tr>
<td>Currant</td>
<td></td>
<td>Flaxseed</td>
</tr>
<tr>
<td>Date</td>
<td></td>
<td>Flint corn</td>
</tr>
<tr>
<td>Figs</td>
<td></td>
<td>Flower corn</td>
</tr>
<tr>
<td>Filbert (hazelnut)</td>
<td></td>
<td>Hay</td>
</tr>
<tr>
<td>Gooseberry</td>
<td></td>
<td>Livestock products</td>
</tr>
</tbody>
</table>

Last Modified Date: 02/23/2012

http://www.ams.usda.gov/AMSpv1.0/getfile?dDocName=STELPRDC5082113
Agriculture in California

- California is the nation’s top agricultural state, and has been for more than 50 years

- More than 60% of the state’s farms are less than 50 acres in size; indicator of the number of specialty crop operations

- California remained the No. 1 state in cash farm receipts in 2010, with $37.5 billion in revenue

- The state accounted for 16 percent of national receipts for crops, and 7 percent of the U.S. revenue for livestock and livestock products
Agriculture in California

- California's agricultural abundance includes more than 400 commodities

- California has been the nation's leading dairy state since 1993 when it surpassed Wisconsin in milk production

- Sales of milk and cream contributed $5.94 billion in 2010

- California ranked number one in the U.S. in the production of fluid milk, butter and nonfat dry milk

- California’s dairies produced 40.4 billion pounds of milk, accounting for 21 percent of the nation's milk supply
“Rapid retreat occurred over the first half of the 20th century beginning in the 1920s and continued through the 1960s”

“1980s glaciers resumed retreat with a rapid acceleration starting in the early 2000s”

“area changes in the study glaciers is a response to regional climate whereas the magnitude of change is influenced by local topographic effects”

“Area changes correlate significantly with changes in summer and winter air temperatures”
Climate Change in California

Lyell Glacier (YNP)

7 August 1903 by G. K. Gilbert (USGS)

5 September 2004 by H. Basagic.
“Although pediatricians may readily be moved to prevent the harm that would result if children lost access to food, water, and clean air, or contracted certain vector-borne diseases, they may be less aware that climate change makes all these unwelcome outcomes more likely.”

“Perhaps the single greatest health concern for children that climate change raises is its potential to greatly reduce the quantity and nutritional quality of food.”
Climate change and children’s health
Aaron S. Bernstein\textsuperscript{a,b} and Samuel S. Myers\textsuperscript{c,d}

- High temperature = more pathogen and crop wilting
- Ozone increase (30-45 ppb) = crop yield decrease (10-40%)
- Rising carbon dioxide may also affect nutritional quality
  - Grains grown at elevated concentrations of CO\textsubscript{2} appear to have reduced concentrations of protein, iron, zinc, and perhaps other nutrients
  - Iron deficiency = anemia = cognitive development
Number 5 Make half your plate fruits and vegetables
Choose red, orange, and dark-green vegetables like tomatoes, sweet potatoes, and broccoli, along with other vegetables for your meals. Add fruit to meals as part of main or side dishes or as dessert

http://www.choosemyplate.gov/
Agriculture and Public Health

The USDA is challenging you to show how you’re adding more fruits and vegetables to your diet without straining your budget.

VIEW THE WINNERS

Congratulations, winners! And thanks to everyone who voted and participated!

http://fruitsandveggies.challenge.gov/
Climate Change and CDFA

CALIFORNIA AGRICULTURAL VISION
Progress Report Released on Ag Vision Released (Spring 2012)

FROM STRATEGIES TO RESULTS

Since the release of the California Agricultural Vision (Ag Vision) report in December 2010, the Ag Vision Advisory Committee has continued progress on the strategies and action items within the report to ensure a vibrant future for the state. The Ag Vision is a strategic plan for the future of the state’s agricultural and food system which was motivated by the rapidly growing list of challenges facing agriculture, from regulations and water suppliers to urbanization and climate change.

The “California Agricultural Vision: From Strategies to Results” documents the ongoing progress of the Ag Vision Advisory Committee’s work and that of other stakeholders in addressing the 12 key strategies for California’s agriculture and food sector.

http://www.cdfa.ca.gov/agvision/
Strategy 9

Assure Agricultural Adaptation to Climate Change

Assure that all sectors of California agriculture can adapt to the most likely climate related changes in seasonal weather, water supply, pests and diseases, and other factors affecting agricultural production.
Climate Change and CDFA

N$_2$O from nitrogen fertilizer research
- 310 X more potent than CO$_2$
- > $1$ million (combined funding between CEC, ARB, CDFA)
- Examined N$_2$O from 10 major crops in California
- Lack of baseline information
- Being evaluated as an agricultural offset protocol

CH$_4$ dairy digester research
- 24 X more potent than CO$_2$
- Lagoons offgas methane
- Waste to energy conversion

Agriculture has global warming mitigation potential
- Carbon sequestration
- Research on organic matter buildup needed

http://www.cdfa.ca.gov/environmentalstewardship/climate.html
Climate Change and Public Health

Where in the cycle will climate change impact?

**DISTRIBUTION**
- Scan-based inventory systems
- Electronic data interchange (EDI)
- Management of point of sale data
- Category management

**PACKAGE/PROCESSING**
- Diagnostic testing for the detection of food contaminants
- High-speed processing mechanization
- Nitrogen-filled salad bags
- Advanced membrane technology
- Biodegradable plastics and packaging

**CONSUMER DEMAND**
- Quality
- Convenience
- Variety
- Reduced environmental impact

**SUPPORT**
- Novel seed varieties
- Pest resistant seed varieties
- Coated seeds for regulating multiple planting
- Recycling of agricultural waste products for construction
- Monitoring technology for air and water quality

**PRODUCTION**
- Diagnostic testing for detection of plant/animal disease and feed contaminants
- Precision irrigation
- GPS-directed micro tractors with weed triggers and herbicide
- Advances in organic production methods

Henton et al. 2006. California’s Food Chain at Work. CA Economic Strategic Panel.
Climate Change and Public Health

Where in the cycle will climate change impact?

Henton et al. 2011. The Food Chain Cluster; Solano and Yolo Counties.
Thanks