



**Climate Change and Agriculture in
California:
Adaptation to Extreme Events**

November 16, 2011

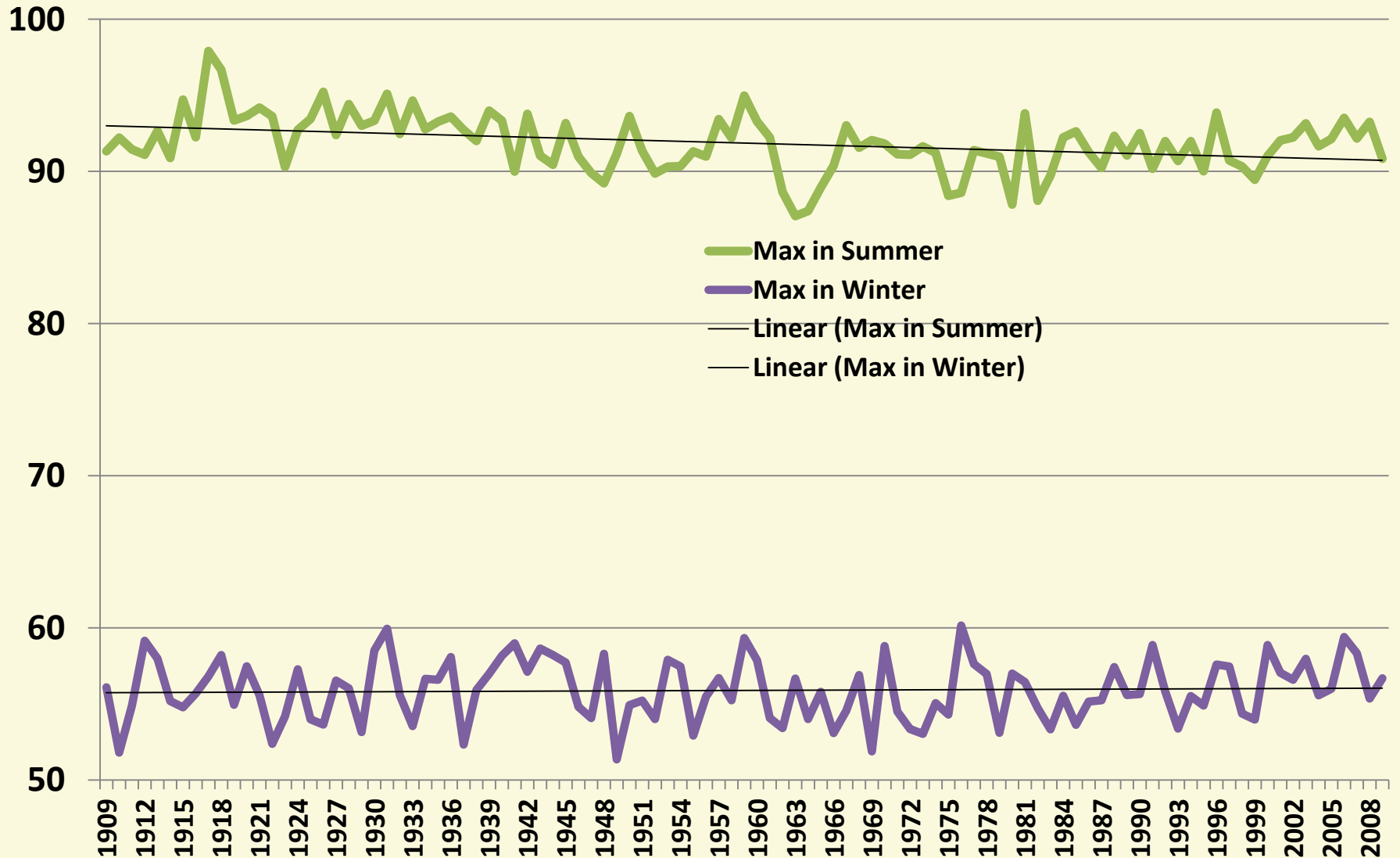
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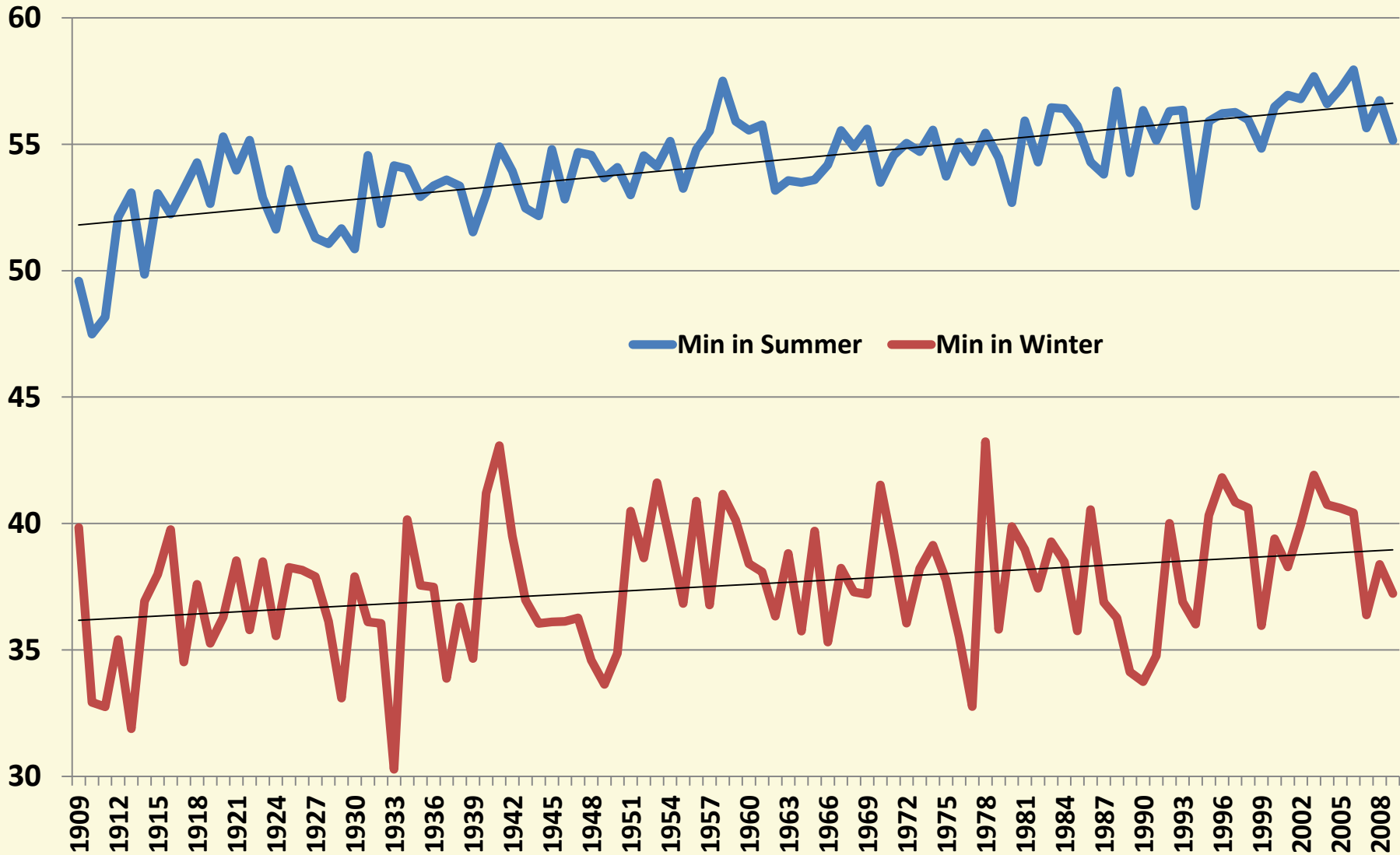
Major Points in the Presentation

- **Previous speakers have documented, climate has been changing in ways relevant to agriculture**
 - **Temperature trends are well documented, higher lows in the winter and the summer**
 - **Climate models suggest more variability, and in some particularly vulnerable regions --east Africa**
- **Climate shifts outside California affect agriculture here directly through the demand side in global markets**
- **Increased climate variability and the frequency and magnitude of extreme weather events affect:**
 - **The supply side and the demand size of agricultural markets**
 - **Prices and quantities (and recall $P \times Q = \text{Revenue}$)**
 - **Producers and consumers**
 - **Individual farms and industries as a whole**

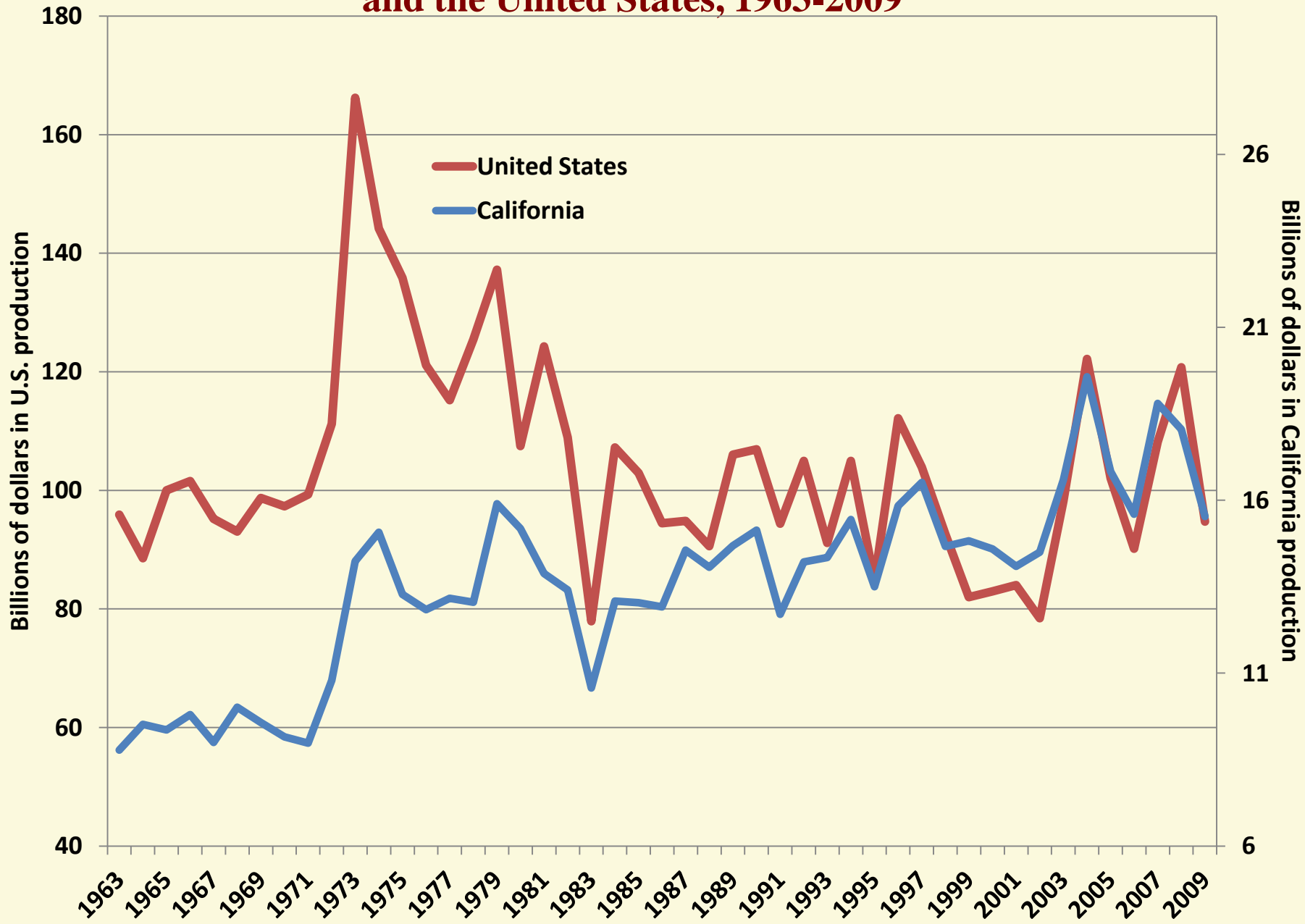
Historical maximum average temperature in summer and winter months for the period of 1909-2008 for Davis, CA



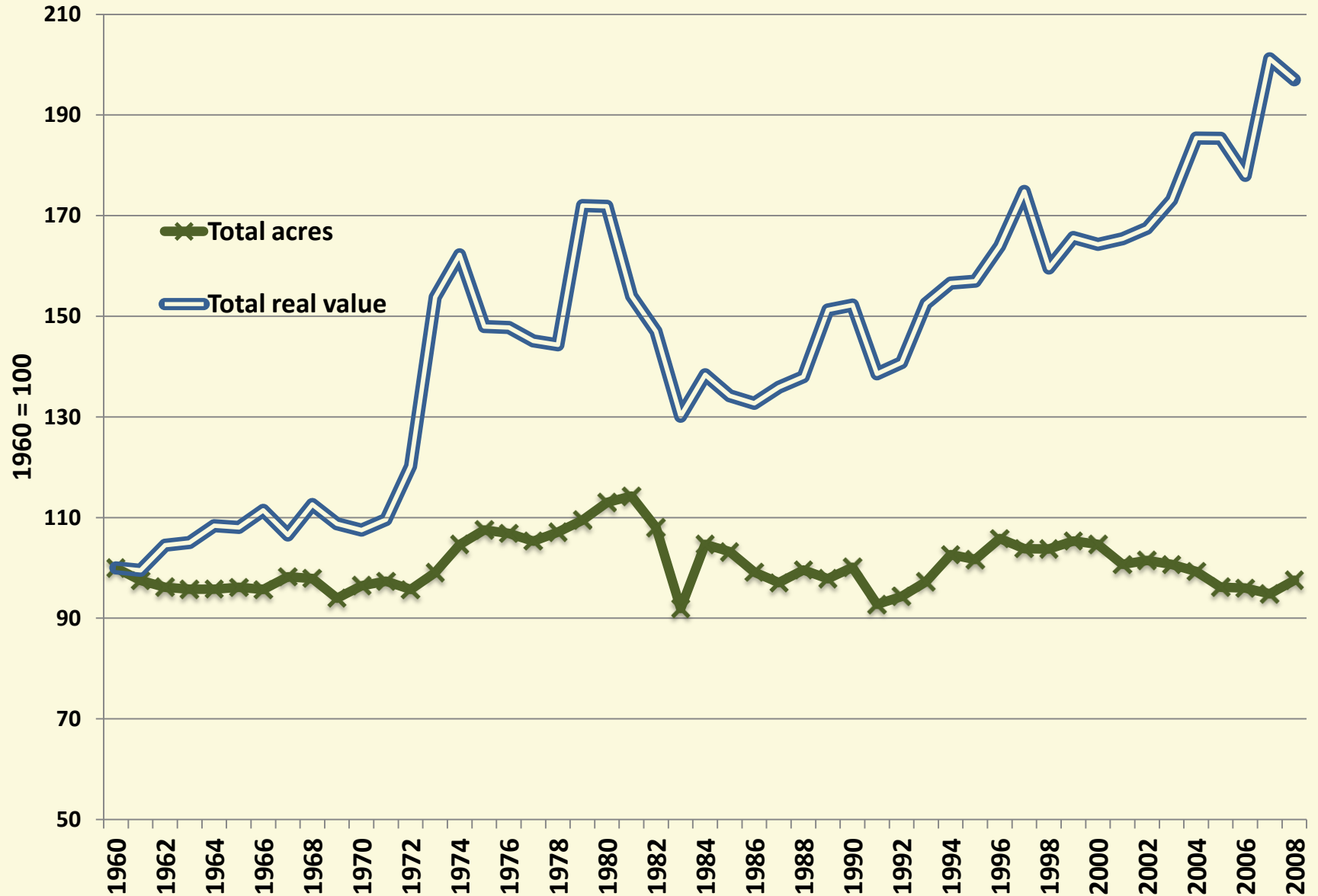
Historical minimum average temperature in summer and winter months for the period of 1909-2008 for Davis, CA



Real gross domestic product from crop and animal production in California and the United States, 1963-2009



Index of acreage and real value of California agricultural output

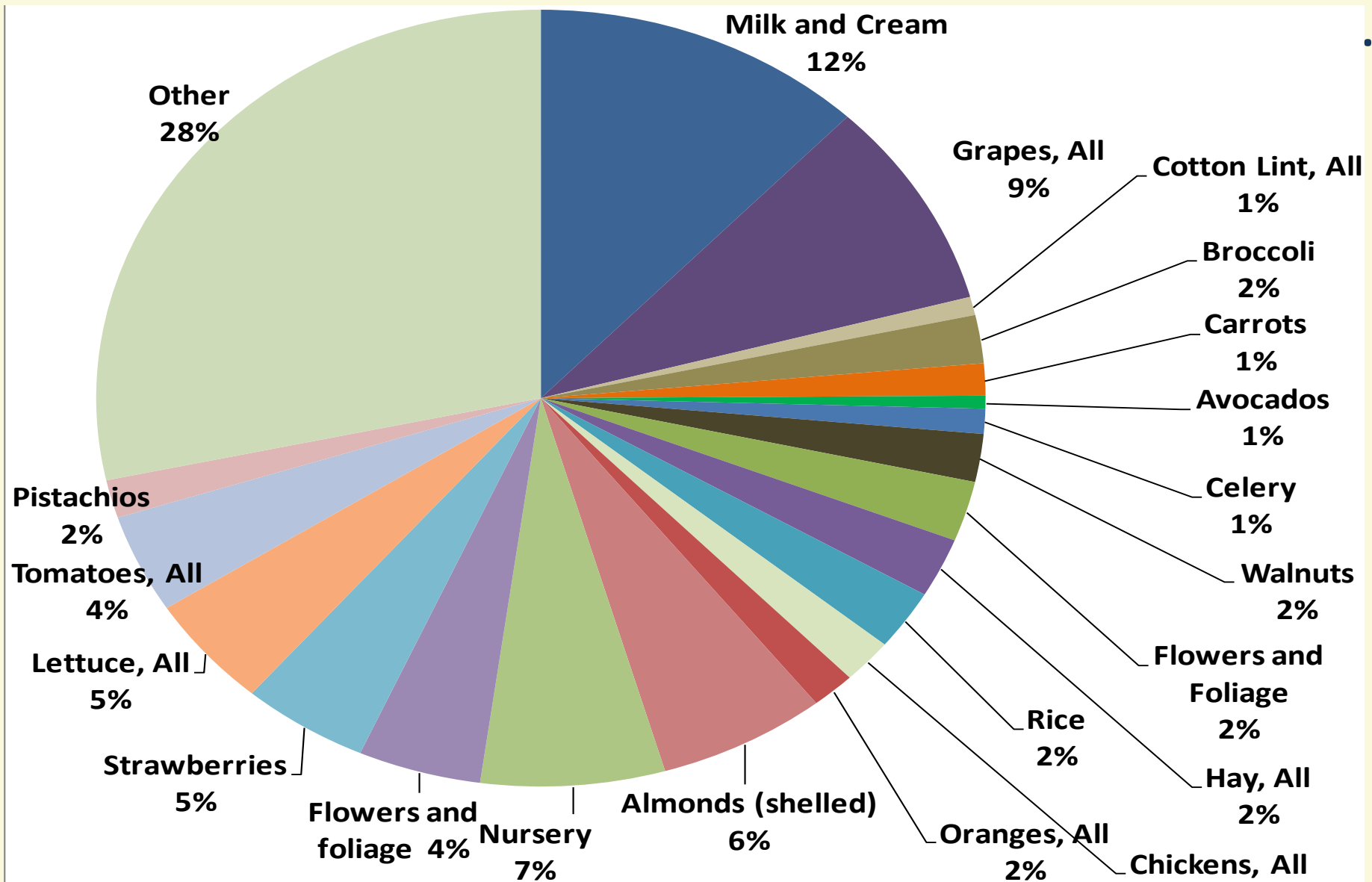


Major Points in the Presentation

- **Impacts of climate on farm revenues and consumers costs may differ depending on where the shocks occur**
- **Four responses to more variability and climate extreme events**
 - **Direct efforts to mitigate climate flux with technology such as tolerant varieties or flexible planting and harvesting**
 - **Storage and other tools for inter-temporal smoothing**
 - **Trade and other tools for spatial smoothing**
 - **Diversification across commodities and locations**

Top Farm Commodities by value, California 2010

Total gross sales ~ \$37.5 billion



Diversification across commodities

- **California commodity diversification is unlike many regions, for example the American Midwest**
- **Commodity diversification means revenue is smoothed when supply or demand shocks occur**
- **Agriculture as a whole is diversified across crops and individual farms also diversify**
- **Farms grow several tree crops or several field crops and have rotations that include grains and hay and tomatoes, for example**

Reminder:

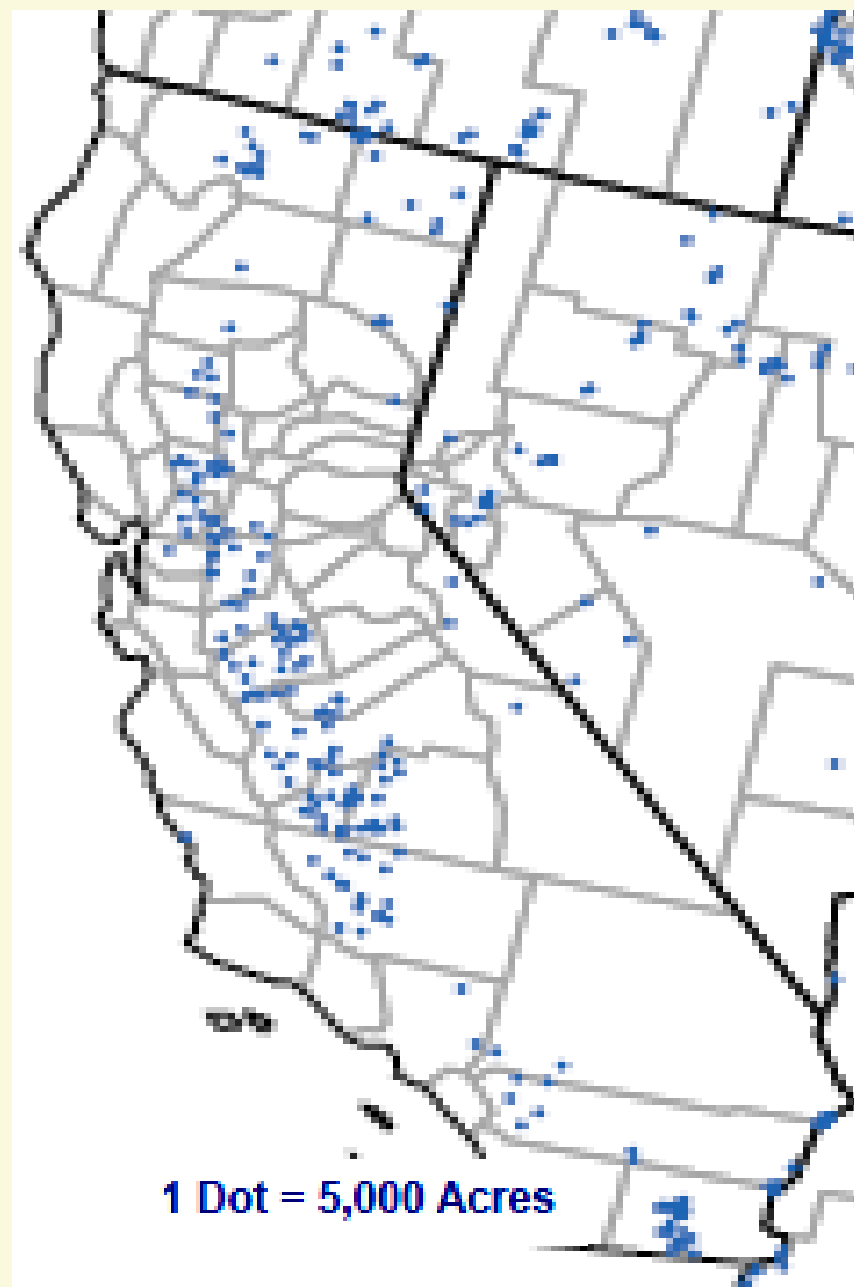
Natural Diversity is California

- California has a wealth of climate diversity even within the zones shown.
- Extreme agriculturally-relevant climate events seldom affect the whole state.



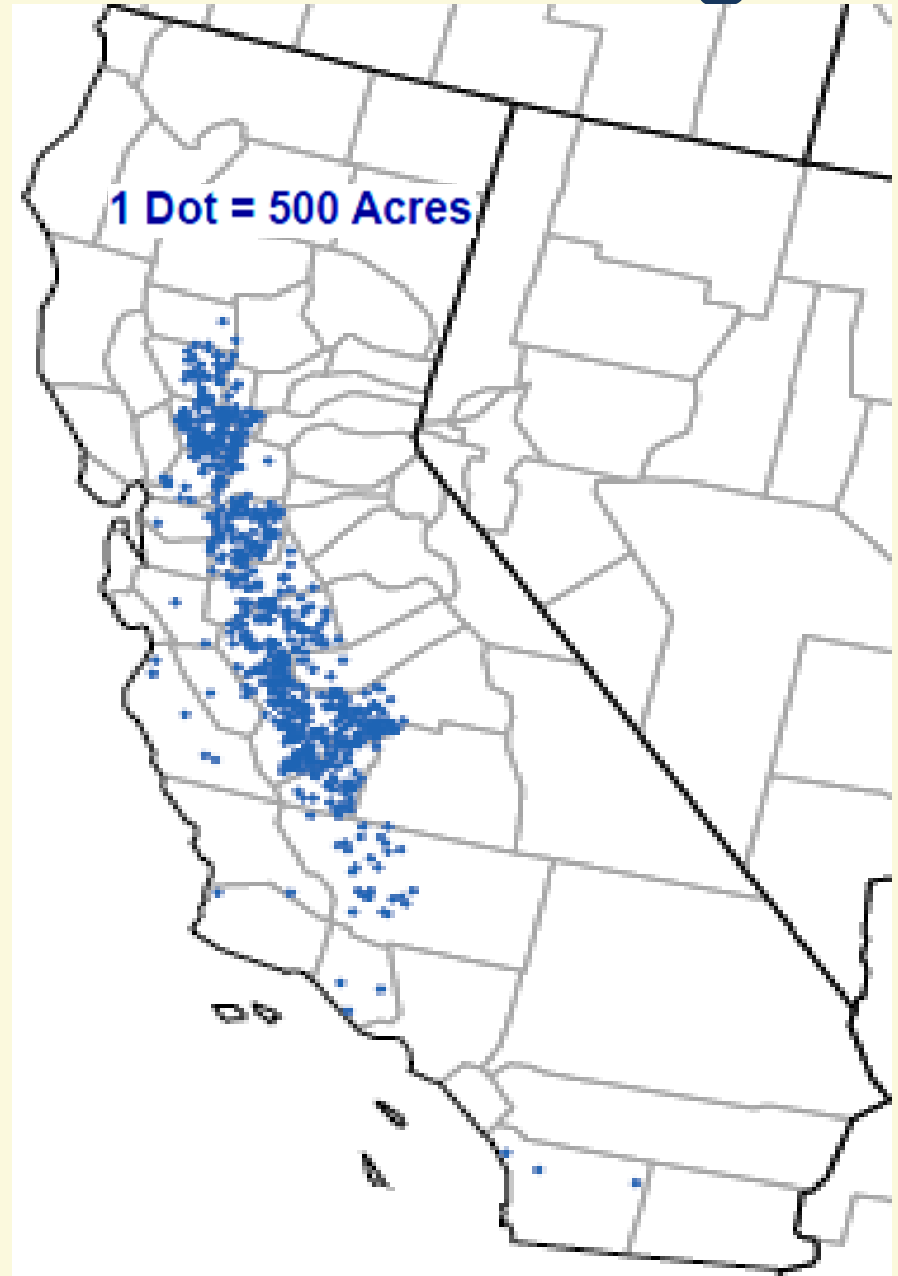
Geographic diversity of alfalfa acreage

- **Alfalfa production ranges from Shasta County to Imperial County, across a variety of climate zones**



Geographic diversity of tomato acreage

- Most tomato acreage is for processing tomatoes
- Tomato acreage is mainly in the Central Valley, but from Chico to Bakersfield
- Production takes place in several climate zones



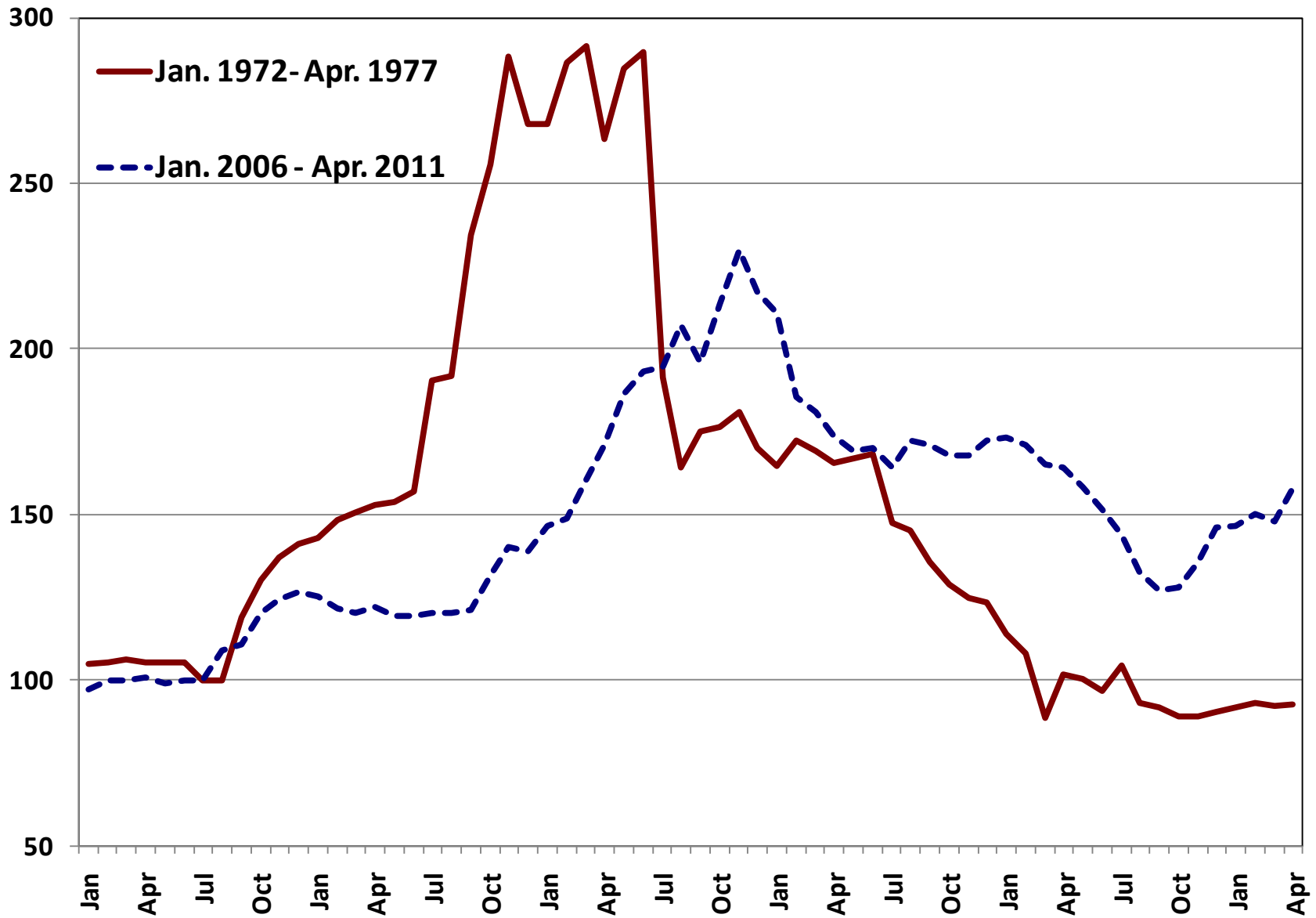
Geographic diversification means smaller variability of production

- Agricultural production of commodities in California is smoothed by diversification across the state**
- Some individual farms also diversify across regions to smooth production losses**
- But, for more localized farms, the fact that aggregate production is spread means price does not rise when local yields fall**
- This point applies with even more force for crops for which California agriculture competes with the rest of the U.S. and the world**

Geographic diversification means smaller variability in prices

- **Recall that for several tree nuts, many fresh vegetables, many fresh fruits and others California produces large or even dominant shares in relevant markets**
- **For these and some crops that feature strongly in local markets, bad weather here can drive price up, smoothing revenue**
- **For others (milk powder, grains, upland cotton ...) price responds much less to local weather and weather and supply and demand conditions elsewhere drive California our markets and prices**

U.S. rice prices, 1972-77 and 2006-2011



Rice in California has particular characteristics

- But the California share in the global market is tiny
- Most price movements from season to season are driven by supply or demand shocks outside California
- Yield and regulatory restrictions are local shocks

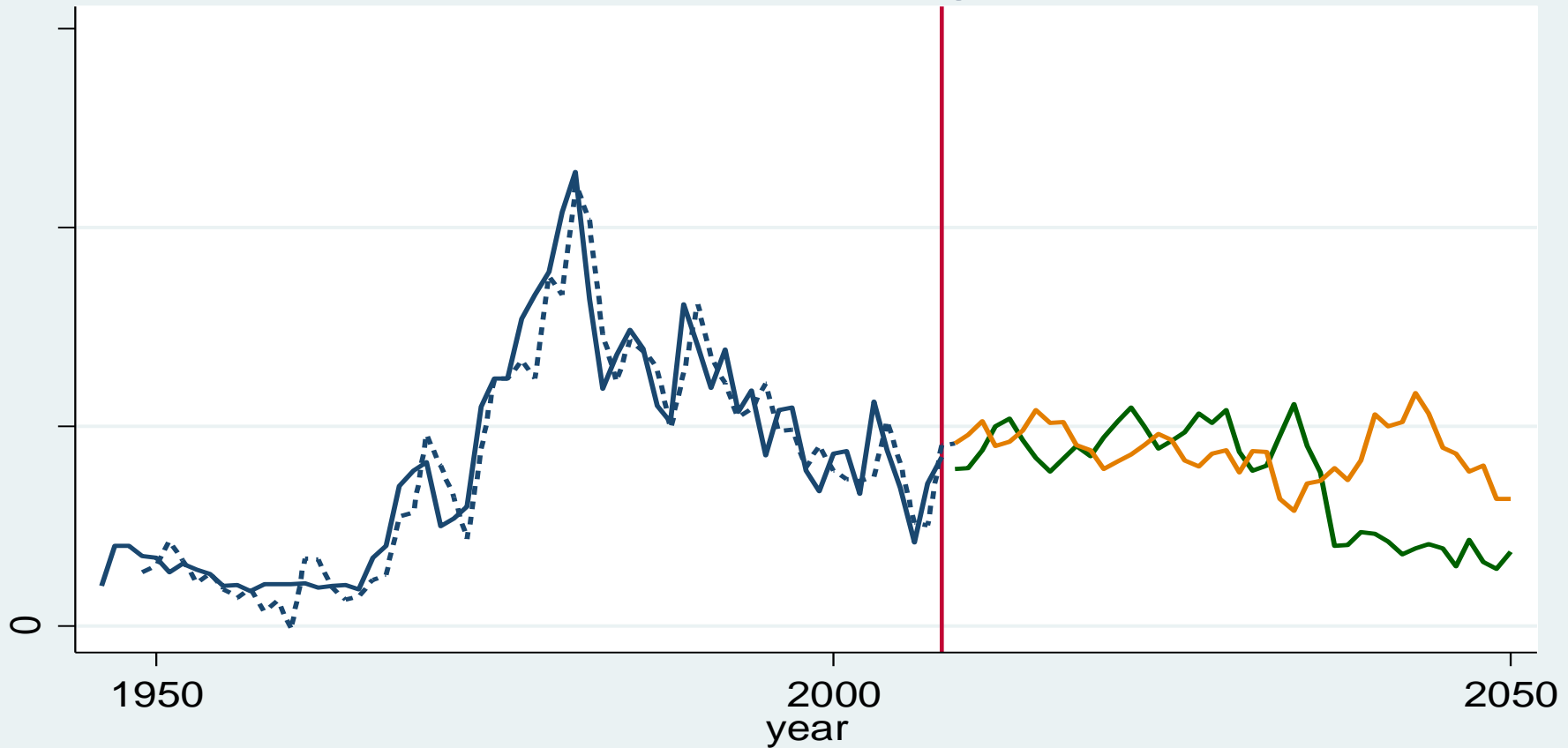


Fabric Collage by Merle Axelrad Serlin

CALIFORNIA RICELANDS
California Rice Commission

Wheat acreage in Yolo County, with projected acreage under IPCC downscaled B1 and A2 climate scenarios, without using data on shifts in variability in the past or projected into the future

Wheat Acreage



Analysis of climate change and potential agricultural responses in Yolo County

Yolo county must take markets as given and thus local climate shocks do little to affect price or consumer availability unless selected demands are focused on local supply

Recent multidisciplinary research lead by Louise Jackson

Jackson, L.E., V.R. Haden, A. Hollander, H. Lee, M. Lubell, V. Mehta, T. O'Geen, M. Niles, J. Perlman, D. Purkey, W. Salas, D. Sumner, M. Tomuta, M. Dempsey, and S. Wheeler. 2011.

“Agricultural Mitigation and Adaptation to Climate Change in Yolo County, CA.”

- **In preparation for a CEC California Climate Change Center Report.**

Policy and Institutional Principles: what can public and private organization do?

- **Enhance information flows, incentives and flexibility**
- **Improved forecasts with longer horizons (such as of el niño events) will have large payoffs**
- **Make technology options more accessible**
- **Adaptation in agriculture is local, but effective policy responses must reflect global impacts and inter-linkages.**
- **Flexible trade will play a critical role in both mitigation and adaptation, but will itself be shaped importantly by climate change.**
- **Avoid limiting incentives for private responses, including diversification, storage and trade**

Responses to Climate change and especially increased variability in poor countries

- **Lybbert, Travis and Daniel A. Sumner. 2012. “AGRICULTURAL TECHNOLOGIES FOR CLIMATE CHANGE IN DEVELOPING COUNTRIES: POLICY OPTIONS FOR INNOVATION AND TECHNOLOGY DIFFUSION.”**
Food Policy, forthcoming 2012.
- **The lessons also apply in California**

Priorities especially relevant for California

- **Invest in agricultural R&D focused on adaptation and flexibility**
- **Encourage development of practices that incorporate rapid response (frost control) or mitigation of impacts (drought tolerant varieties)**
- **Allow shifts in production patterns without removing incentive through subsidies for the status quo (as in government provided insurance)**

Thank you.
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