Using downscaled climate products to enhance decision-making in US agriculture: current applications and future needs

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Workshop on Impact Relevance and Usability of High Resolution Climate Modeling and Datasets

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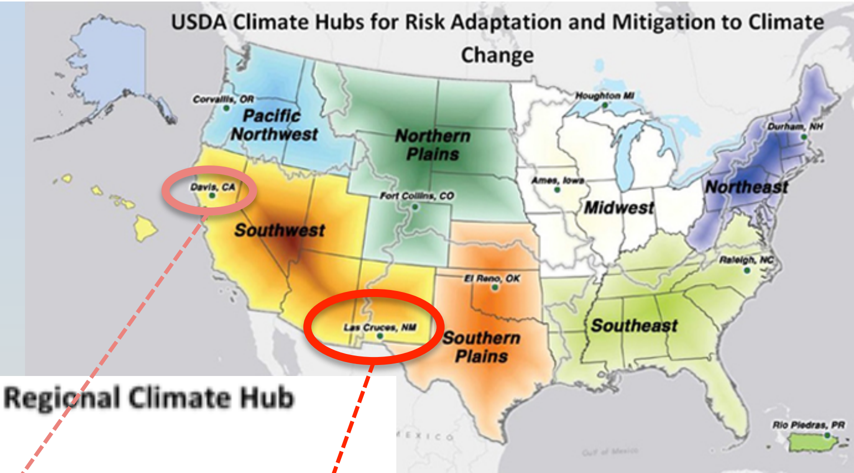
United States Department of Agriculture
CALIFORNIA SUB HUB OF THE SOUTHWEST REGIONAL CLIMATE HUB

Talk outline

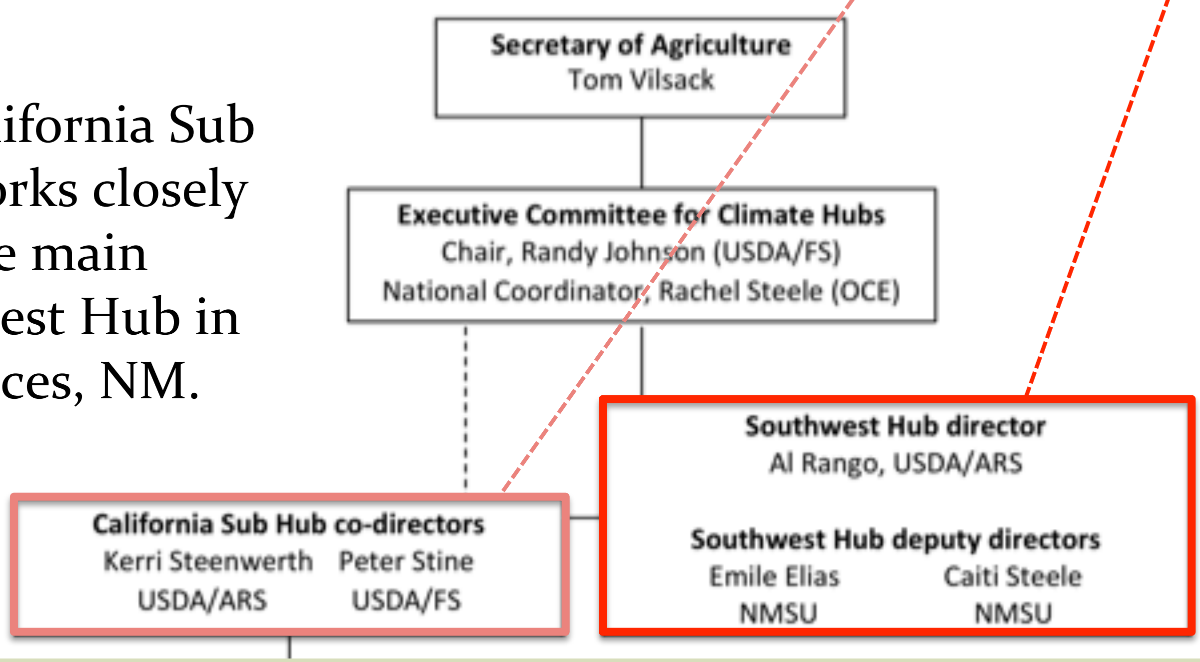
- Introduction to the USDA Climate Hubs
- Scale of this talk: Farmer decision-making (not regional modeling or policy)
- Farmers' beliefs and attitudes toward climate
- Why US farmers don't use climate forecasts
- How climate may affect decision making for
  - Corn
  - Beef cattle
  - Almonds

- Summary and recommendations

The USDA Regional Climate Hubs



Organizational chart for the California Sub Hub of the USDA Southwest Regional Climate Hub

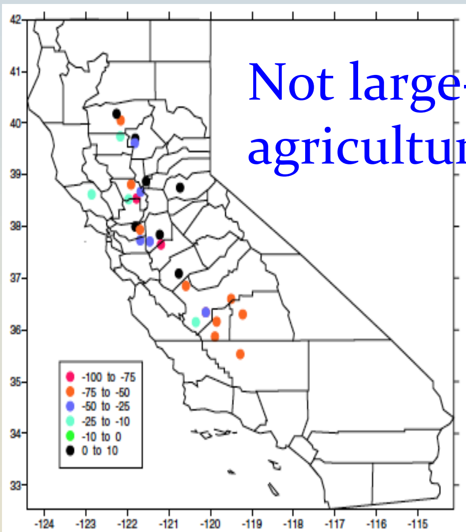


The California Sub Hub works closely with the main Southwest Hub in Las Cruces, NM.

In early 2014, USDA created seven Regional Climate Hubs to serve the whole US, plus three Sub Hubs to focus on unique issues and locations.

The Hubs are **boundary organizations** to bridge the gap between **climate researchers** and the information needs of **farmers, ranchers, and foresters**.

Scale of this talk: Farmer decision-making



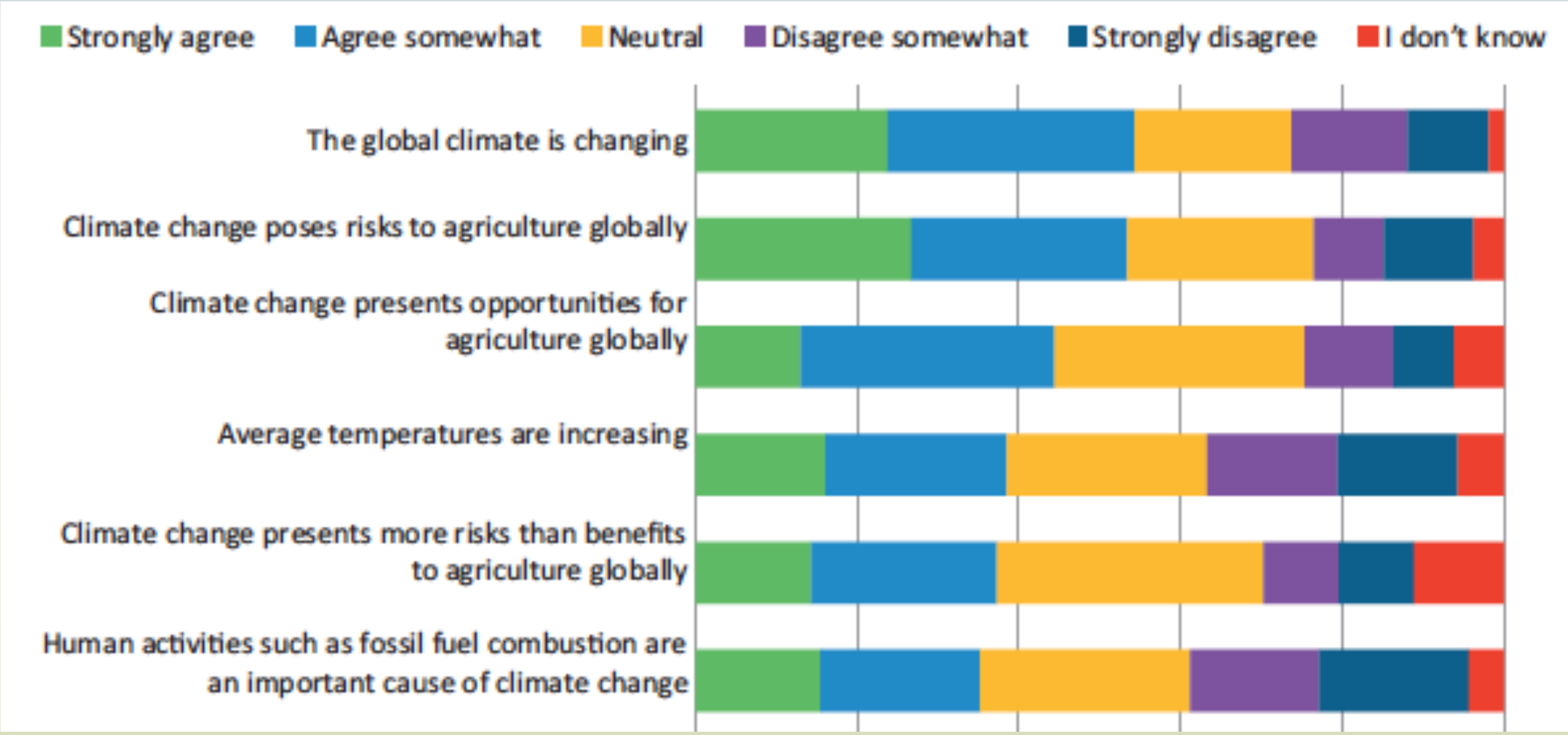
Not large-scale, long-term agricultural impacts modeling…

Not policymaking of any kind…

Not public infrastructure planning…

…rather, **what producers do on their land**, day to day and year to year.

Many US farmers are skeptical about climate change…



Results from a 2010-2011 survey of 162 farmers in Yolo County, California. (Niles et al., 2013)

…and are not highly concerned about climate change impacts…

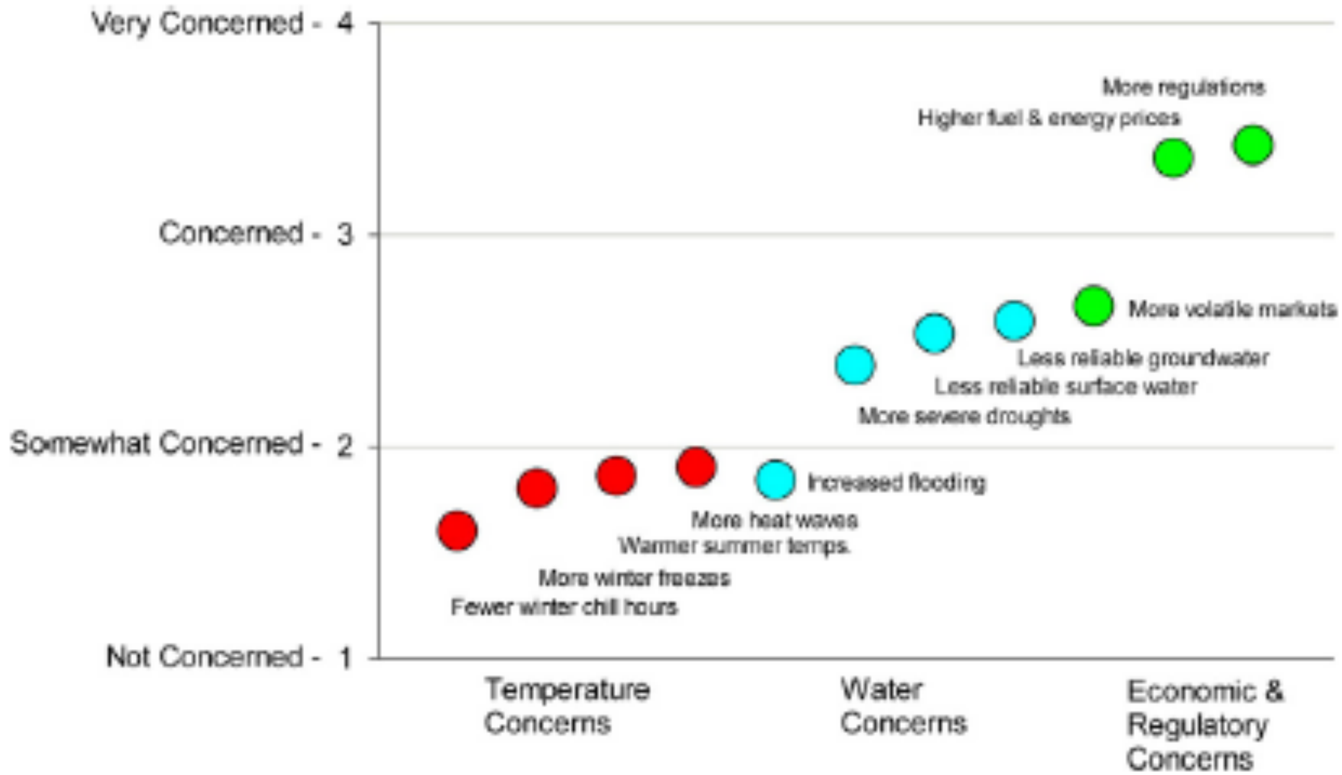


Fig. 1. Average level of concern for local climate change impacts. Farmers' responses to the question, "How concerned are you about the following climate-related risks and the future impact they may have on your farming operations during your career?" Responses are ranked on a four point scale ranging from very concerned to not concerned.

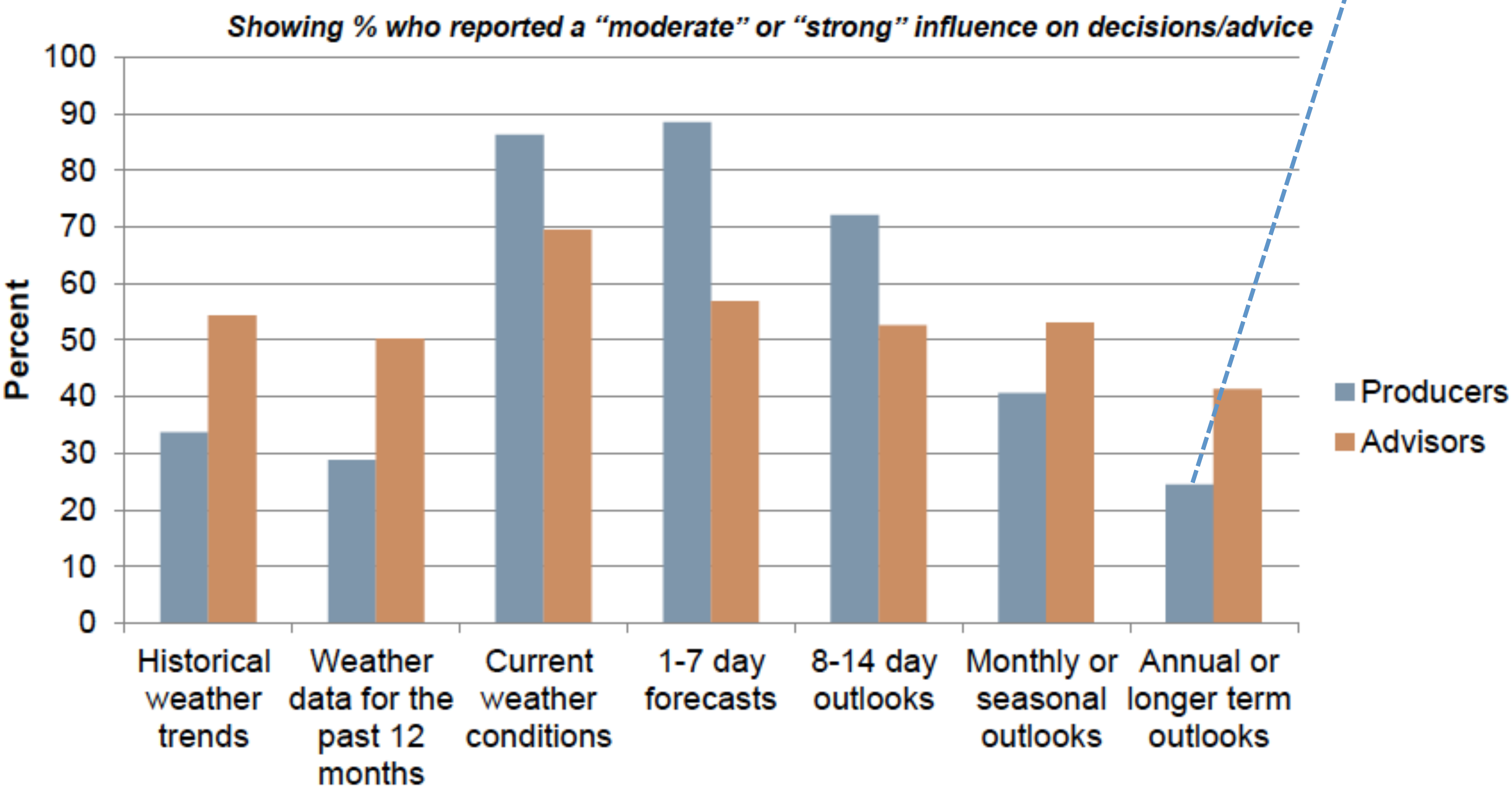
Results from a 2010-2011 survey of 162 farmers in Yolo County, California. (Niles et al., 2013)

…in part because farmers are used to coping with climate variability.

Niles et al., 2013: **Seventy-six percent** of farmers stated **confidence in their ability to adapt** to climate change compared with only 8% of farmers stating pessimism for their adaptive potential:

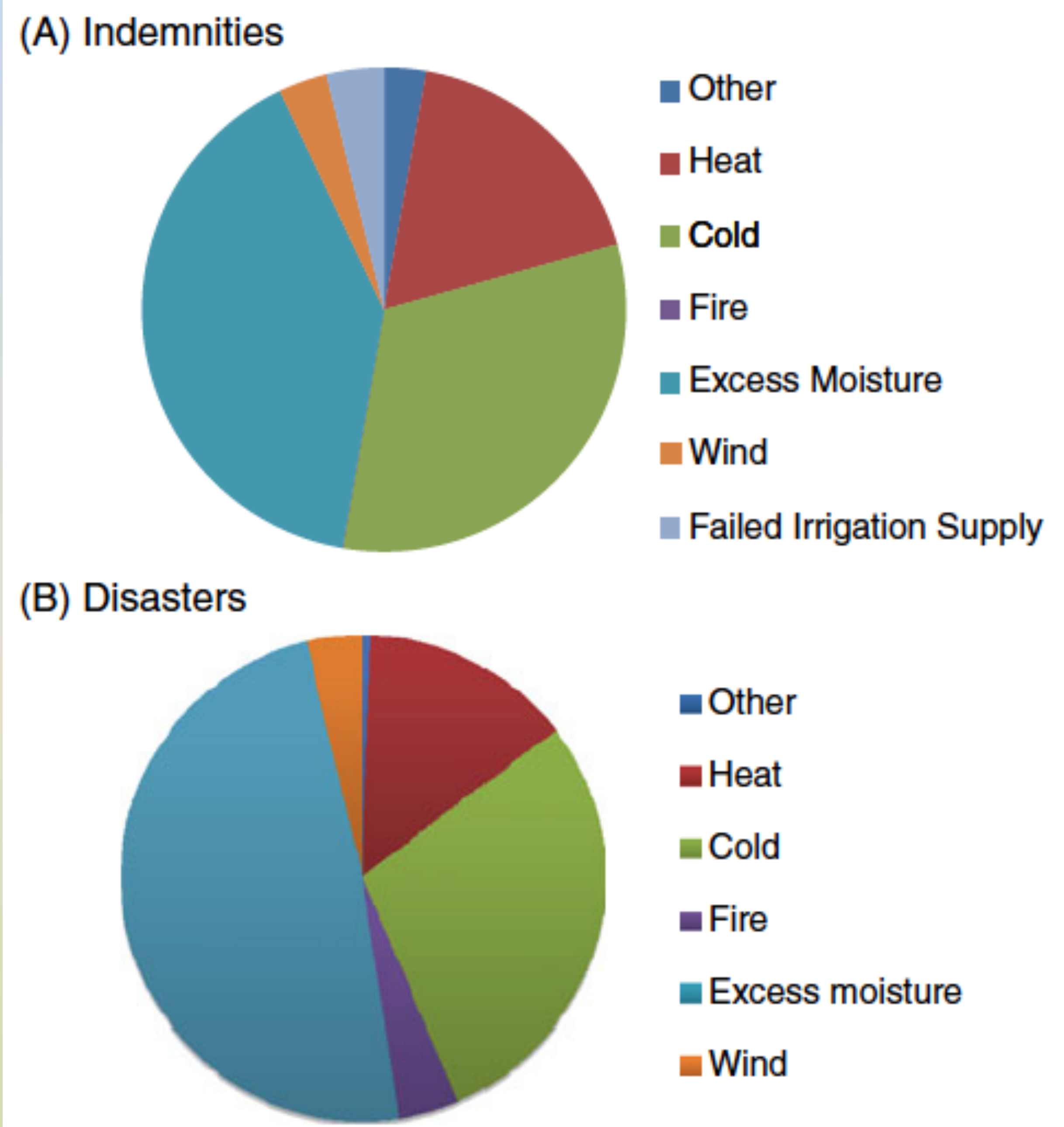
- "I have **other more important things** that affect my business or my family that I want to spend time on."
- "I think that with the years of experience in farming that we have, I think we know how to deal with problems. I think **farmers in general are fairly adaptable**."
- "I'll have to react to [climate change] and adapt to it. But that's been my business. **In agriculture you're dealing with the weather**."

Farmers care more about near-term weather than climate forecasts.



Prokopy et al. 2013. "Agricultural Advisors: A Receptive Audience for Weather and Climate Information?" *Weather, Climate, and Society*, 5:162-167

Agriculture is profoundly affected by weather (averages & extremes)



Causes of **insured crop losses** in California: (A) indemnity; (B) natural disasters, 1980-2007. Data: USDA Risk Management Agency. (Lobell et al., 2011)

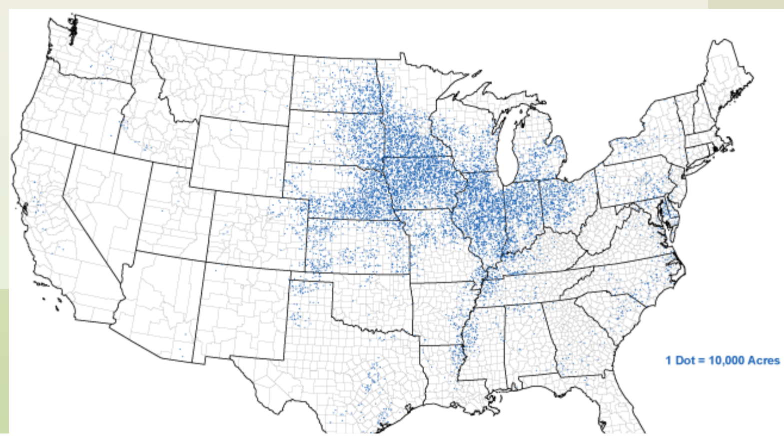
So why aren't US farmers interested in using climate predictions?

- Current tools and models are not widely used, as they **may not be meeting farmers' needs** (Mase & Prokopy, 2013).
- **Average annual temperatures are not** usually the most important variable (Baldocchi & Wong, 2007). Finer temporal resolution is needed.
- Key metrics may differ with crop, but the most generally useful metrics may be: **thresholds** at the upper and lower tails of probability distributions, and **timing** of certain temperature or rainfall regimes (Baldocchi & Wong, 2007).

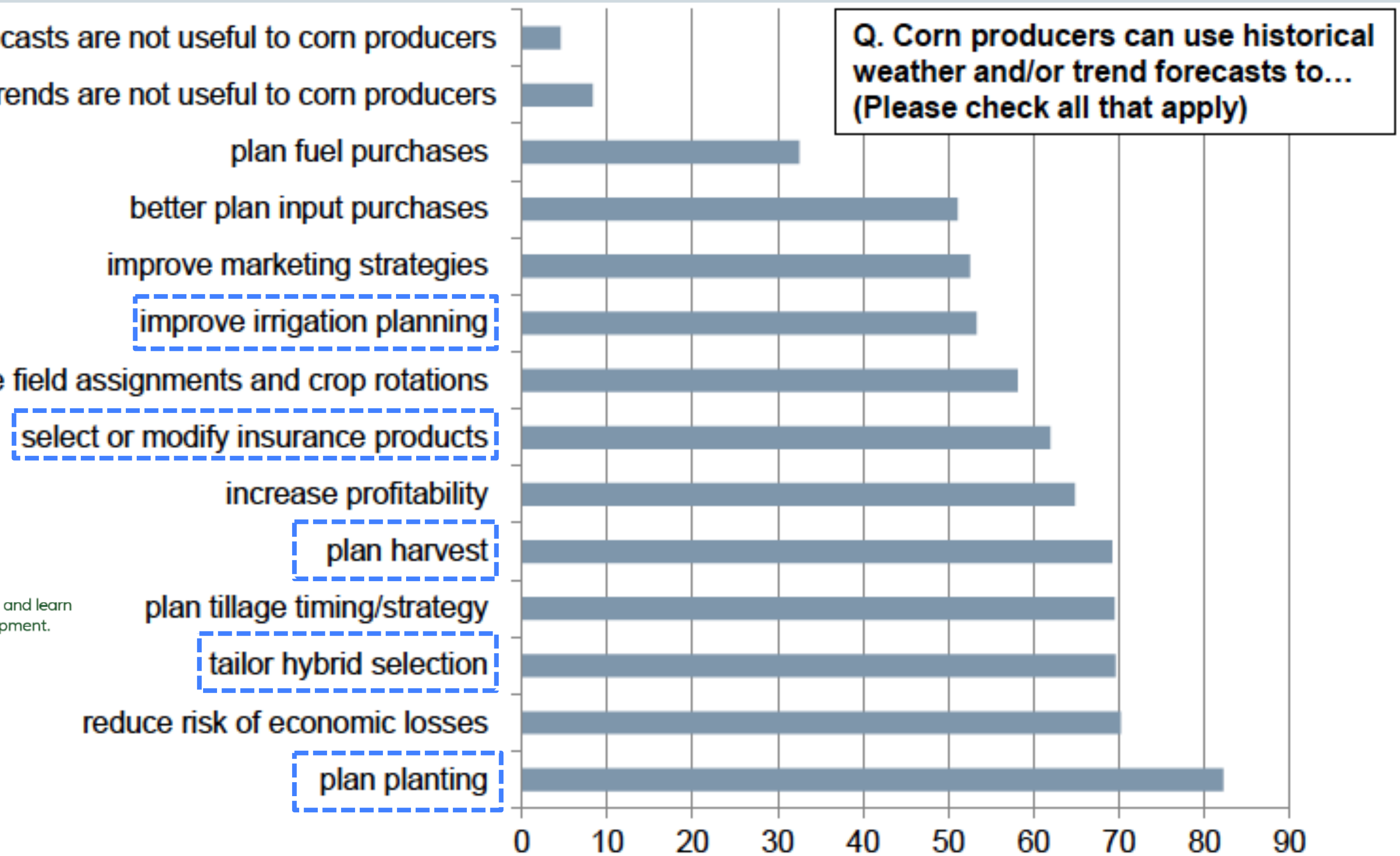
Example 1: Corn

- Corn is the **most valuable US crop** ($67 billion in 2012).
- US corn is about **80% rainfed**, 20% irrigated.
- Corn, an annual crop, usually requires management decisions on the time scale of **less than one year**.
- "Corn farming… is very sensitive to drought and low soil moisture. Decisions made on the time scales of weeks to seasons rely on **short-term and seasonal forecasts** of the soil moisture, which have become invaluable tools to **help farmers decide on irrigation needs** during drought conditions."

National Research Council (2012). *A National Strategy for Advancing Climate Modeling.* doi:10.2172/1056475



Decisions for which corn farmers use weather and trend forecasts



Corn GDD_{DST}

Track real-time GDD accumulations and learn about climate risks for corn development.

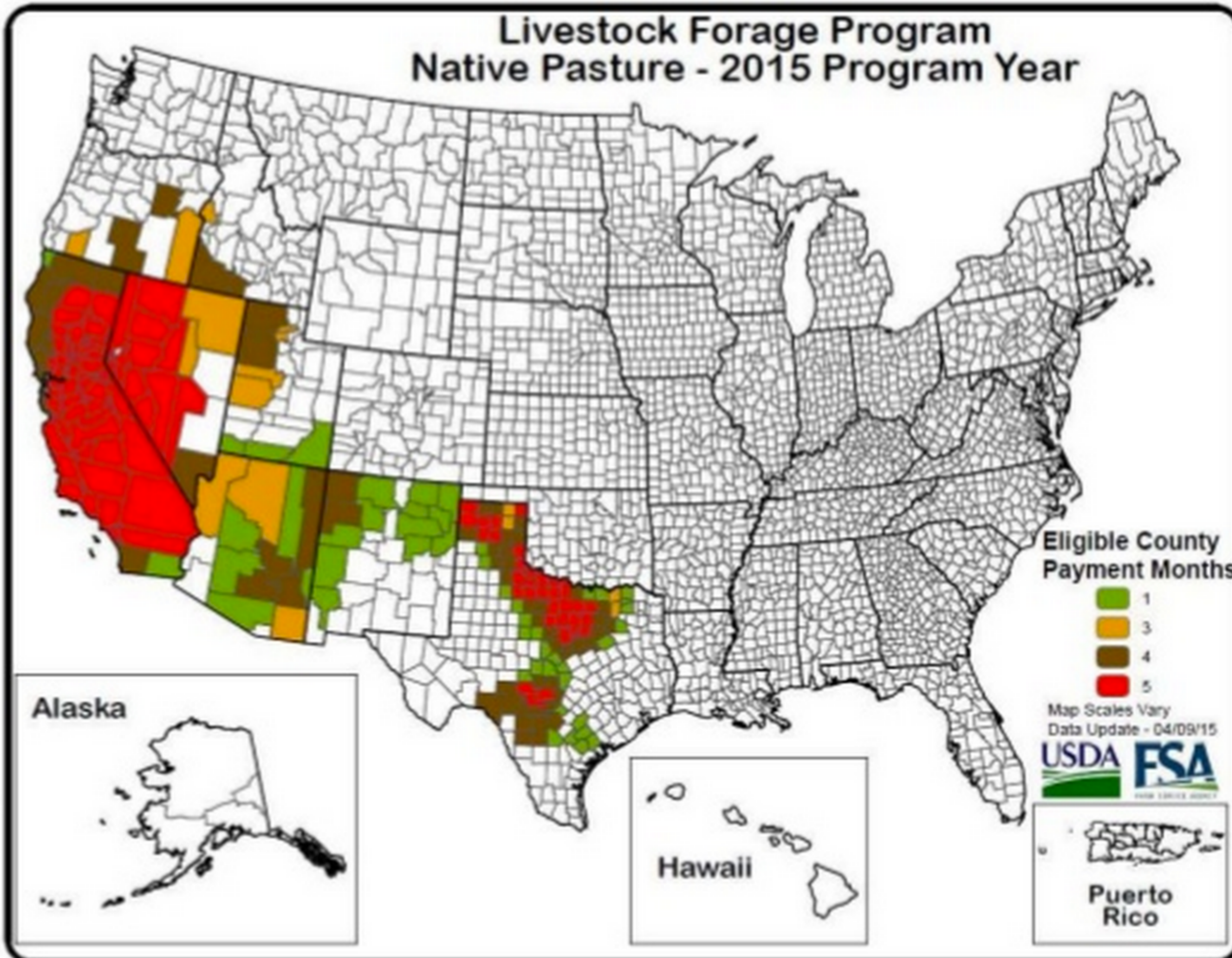
Prokopy et al. 2013. "Agricultural Advisors: A Receptive Audience for Weather and Climate Information?" *Weather, Climate, and Society*, 5:162-167

How might climate change affect corn production in the US?

- Temperatures **above 86°F decrease corn yields**. The more time spent above 86°, the lower the yield (Lobell et al., 2013).
- The 86°C threshold will be **exceeded more frequently** as global temperatures increase.
- So what's a corn farmer to do? Right now, **probably nothing**. There's no way to protect corn in the field from a heat wave (though irrigation can help a little). In the long term, **new heat-tolerant varieties** may be needed.

Example 2: Beef cattle

- Beef producers in California are struggling due to the **drought, now in its 4th year**, that has devastated forage production on rangelands.
- "**When will it end?**" Should a struggling rancher keep buying supplemental feed, take out more loans, or just give up and sell the whole herd?
- Unfortunately, climate **models could not predict** the drought's onset and duration. Models **disagree** on whether similar droughts will become more common in the future.



Livestock Forage Program
Native Pasture - 2015 Program Year
Eligible County Payment Months
1
3
4
5
Map Scales Vary
Data Update - 04/09/15
USDA
FSA
Alaska
Hawaii
Puerto Rico

California ranchers' drought strategies

	Drought Management Practices	% (n = 490)
Proactive	Employ conservative stocking rates	34
	Incorporate pasture rest into grazing system	23
	Incorporate both cow-calf and stockers for flexibility	21
	Grass bank/Stockpile forage	12
	Use 1-3 month weather predictions to adjust stocking	11
	Add other livestock types for flexibility	3
Reactive	Reduce herd size	70
	Purchase feed	69
	Apply for government assistance programs	39
	Wean early	39
	Rent additional pasture	26
	Move livestock to another location	24
	Earn off-ranch income	23
	Sell retained yearlings	22
	Place livestock in a feedlot	8
	Allow livestock condition to decline	7
	Add alternative on-ranch enterprise	4

Results from a summer 2011 survey of California ranchers. (Roche, 2014)

Example 3: Almonds

- Almonds are California's **most valuable** crop: $6 billion per year, which is 80% of the world's supply.
- Almond orchards require **major investment** in irrigation and harvesting equipment.
- For good yields, most almond cultivars require about **400 chill-hours** (hours below 45°F).
- Almond trees take 3-5 years to mature and have a **25-30 year** productive lifespan, which may expose them to a **different climate** in the future.

Some of an almond farmer's decisions

History	1
Marketing	3
Economic Considerations	9
The Evaluation and Modification of Physical Soil Problems	20
Salinity Management	29
Irrigation Systems	41
Orchard Planning Design and Development	47
The Evaluation and Selection of Current Varieties	52
Rootstocks	61
Propagation	64
Genetic Improvements	70
Genetic Disorders	76
Virus Phytoplasma and Union Disorders	88
Growth and Development	90
Bud Development Pollination and Fertilization	98
Photosynthesis and Respiration	103
Root Systems and Root Physiology	107
Physiological Aspects of Water Use	113
Nutrients in the Soil	116
Training Young Trees	121
Pruning Bearing Trees	125
Bee Management for Pollination	132
Frost Protection	155
Measuring Soil Moisture	167
Irrigation Scheduling	171
Nutrition Deficiencies and Toxicities Diagnosing and Correcting Imbalan	179
Nitrogen Usage	189
Orchard Floor Management	196
Insect and Mite Pests	202
Diseases of Almond	214
Nematode Parasites	220
Vertebrate Pest Management	224
Vegetation Management	237
Sprayers and SprayApplication Techniques	245
Preparing for Harvest	254
Harvesting	260
Preventing Tree Injury During Shaking	265
Drying Hulling and Shelling	268
InPlant Storage	274
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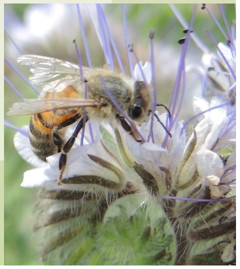
Copyright	

Micke, Warren (1996). *Almond Production Manual.*
University of California Agriculture & Natural Resources.

Climate effects on almond production

- The clearest climate risk for almonds is a **decrease in chill-hours**. Much modeling effort has been devoted to this issue (e.g., Luedeling et al., 2009), but changes have not been made on the ground.
- Other key parameters (such as **frost risk**, timing of **spring rainfall**, and hours favorable for **bee** activity) have not yet been modeled, but can be.
- Future **water availability** is a concern because perennials “lock in” water demand – they can’t be fallowed or replaced. But almond farmers irrigate with groundwater and with delivered surface water, adding a **complex policy aspect**.



Answers to the assigned questions

1) What phenomena are most important for assessing impacts and informing decisions in agriculture?
2) What are the potential ways in which higher resolution products may or may not enhance agricultural capability?
3) What more is needed to improve the credibility, impact relevance, and usability of potential future high resolution datasets?

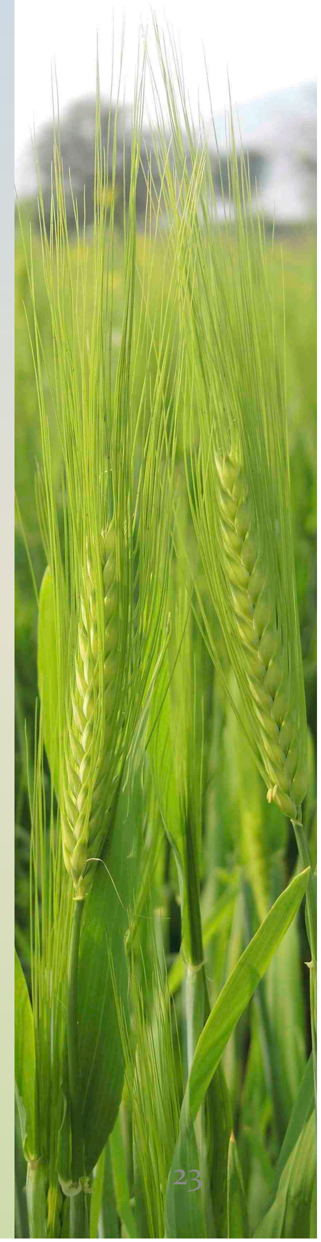
1. What phenomena are most important for assessing impacts and informing decisions in agriculture?

- This very much depends on crop and location.
- *Most consistently relevant*: extreme events such as heat waves, severe freezes, and floods.
- *Sometimes relevant*:
  - Timing and/or amount of precipitation.
  - Time spent below (chill-hours) or above (GDD) a given temperature.
- *Often not relevant*: Minor increments in annual (or seasonal) temperatures.

2. What are the potential ways in which higher resolution products may or may not enhance agricultural capability?

- Low **resolution is *not*** the primary reason that farmers do not use climate data. Rather…
- Farmers tend to make decisions on **time scales** at which **climate forecasts are not relevant** or not available (days, months, a year or two).
- Where resolution is an obstacle, often **temporal resolution** is **more important** (e.g., to predict freezes, chill-hours, GDDs).
- Better **spatial resolution** will be crucial for **a few crops** in particular **locations** (e.g., Napa vineyards)

2. How enhance ag capability? (cont'd)



- To **directly** benefit individual farmers, high-resolution climate data **must help farmers improve the daily decisions they are already making** - for example, what varieties to plant; what irrigation equipment to install; whether to buy disaster insurance.
- The **indirect benefits of** high-resolution climate data are also important (via large-scale analyses; policymaking; and infrastructure planning (*slide 4*), but these benefits are left to others to discuss.

3. What more is needed to improve credibility, impact relevance, and usability of high resolution datasets?

- Evaluate climate information **needs for particular crops and users** (Mase and Prokopy, 2015). *We will soon do this for almond growers in California.*
- Focus on **end users other than farmers**:
  - Extension agents / crop advisors
  - Crop insurance representatives
  - Plant breeders
  - Input providers (e.g. fertilizer and seed dealers)
- Offer climate forecasts in same venues and formats as **weather products** that are already frequently used.

Recommendations and conclusions

- **Lack of a participatory approach** to climate forecasting has **limited the usefulness** of climate forecasts to decision makers in the agriculture sector.
- However, even if climate forecasts are carefully tailored, they **may never be a primary concern** for some farmers. Other factors may dominate, such as government policies and market dynamics.
- Farmers are used to weather variability, and many assume "**consistency eventually pays off**" rather than constantly adjusting strategies (Mase & Prokopy, 2013)
- To adopt bolder (rather than no-regrets) adaptation strategies, farmers will need **concrete information on the costs and benefits** of doing so (GAO, 2014).

References

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Thank you! Questions?

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