Presentation from the USDA Agricultural Outlook Forum 2017

United States Department of Agriculture
93rd Annual Agricultural Outlook Forum
"A New Horizon: The Future of Agriculture"

February 23-24, 2017
Arlington, Virginia

USDA
United States Department of Agriculture

Water Scarcity and Farmer Adaptation

Agricultural Outlook Forum
February 24, 2017

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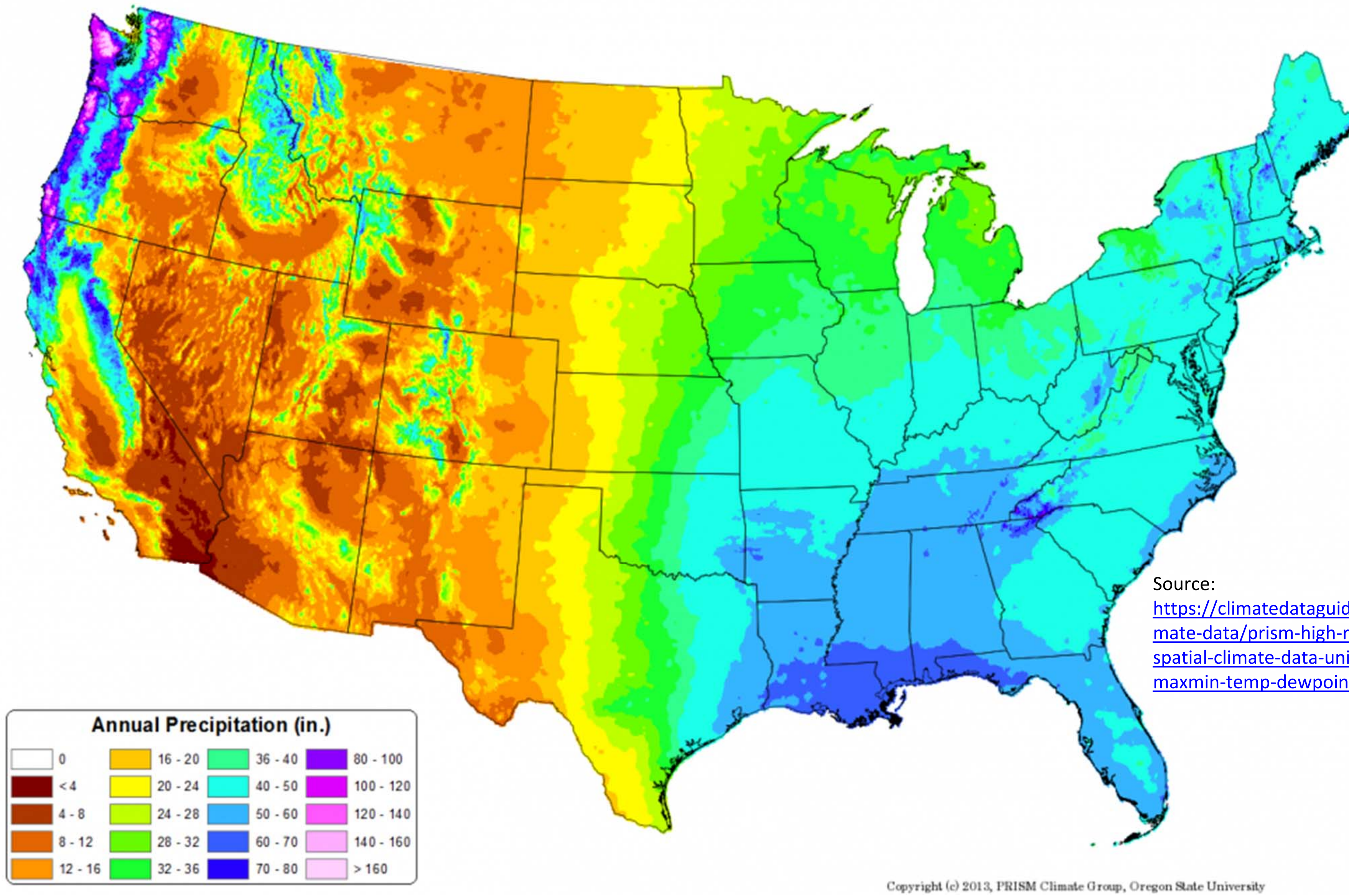
Overview of Key Themes

- **Water is scarce**, much like other inputs to agricultural production – land, labor, nutrients.
- **Drought** is a key form of water scarcity for agricultural production.
- Farmers, commodity markets, and governments are involved in **drought response**.
- Farmers **adapt to drought risk** in many ways – land use, crop choice, irrigation investment, and government program participation.

Variations of Water Scarcity

- Location
- Timing
- Uncertainty / Variability
- Competition

Location Matters: 30 Year Normal Precipitation (1981-2010)

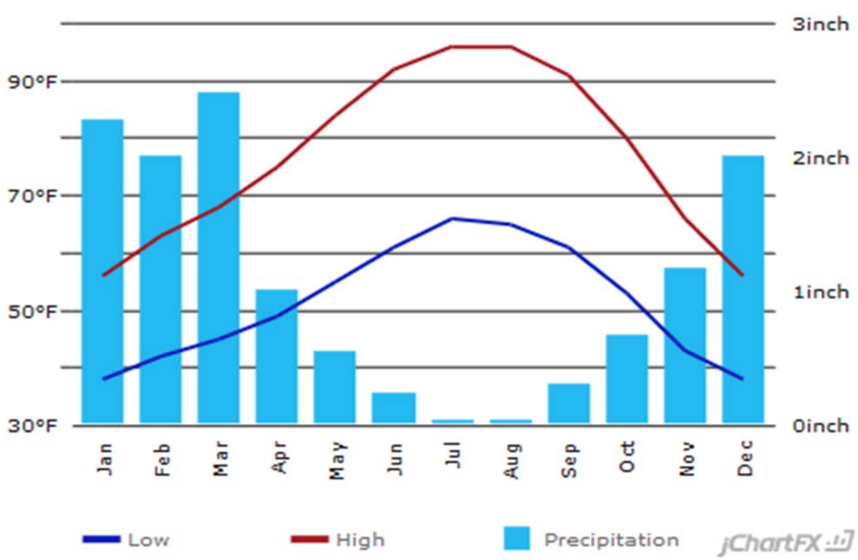


Source: https://climatedataguide.ucar.edu/climate-data/prism-high-resolution-spatial-climate-data-united-states-maxmin-temp-dewpoint

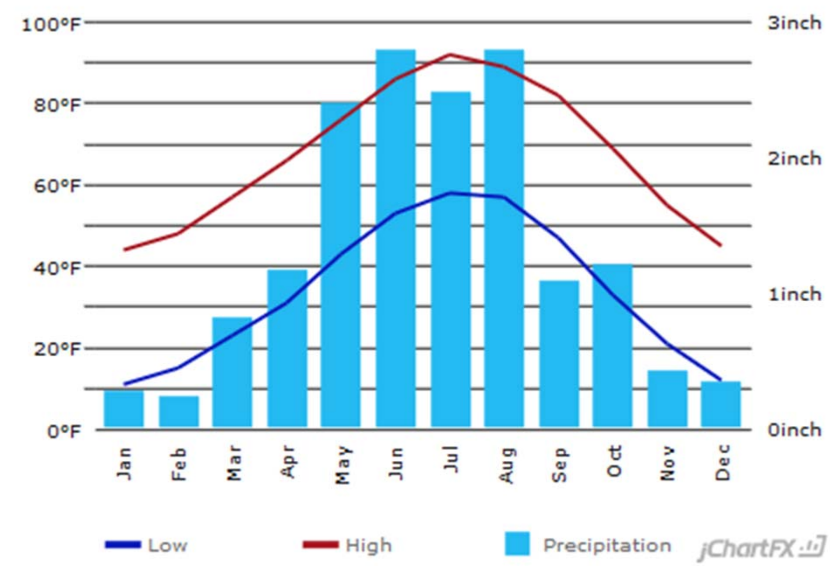
Timing Matters: CA versus CO

Average (1981-2010) Temperatures and Precipitation, by month

Fresno, California

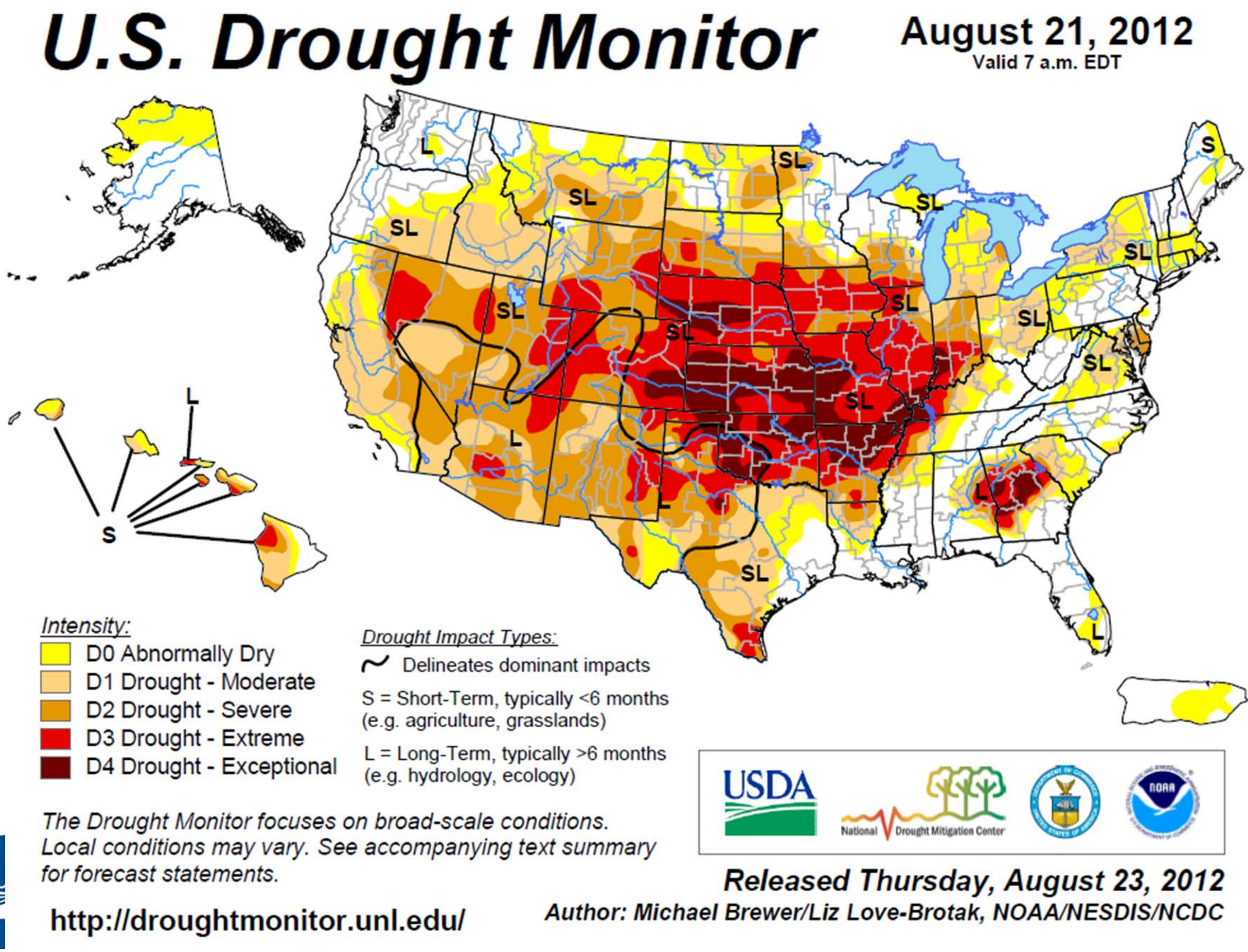


Kit Carson, Colorado

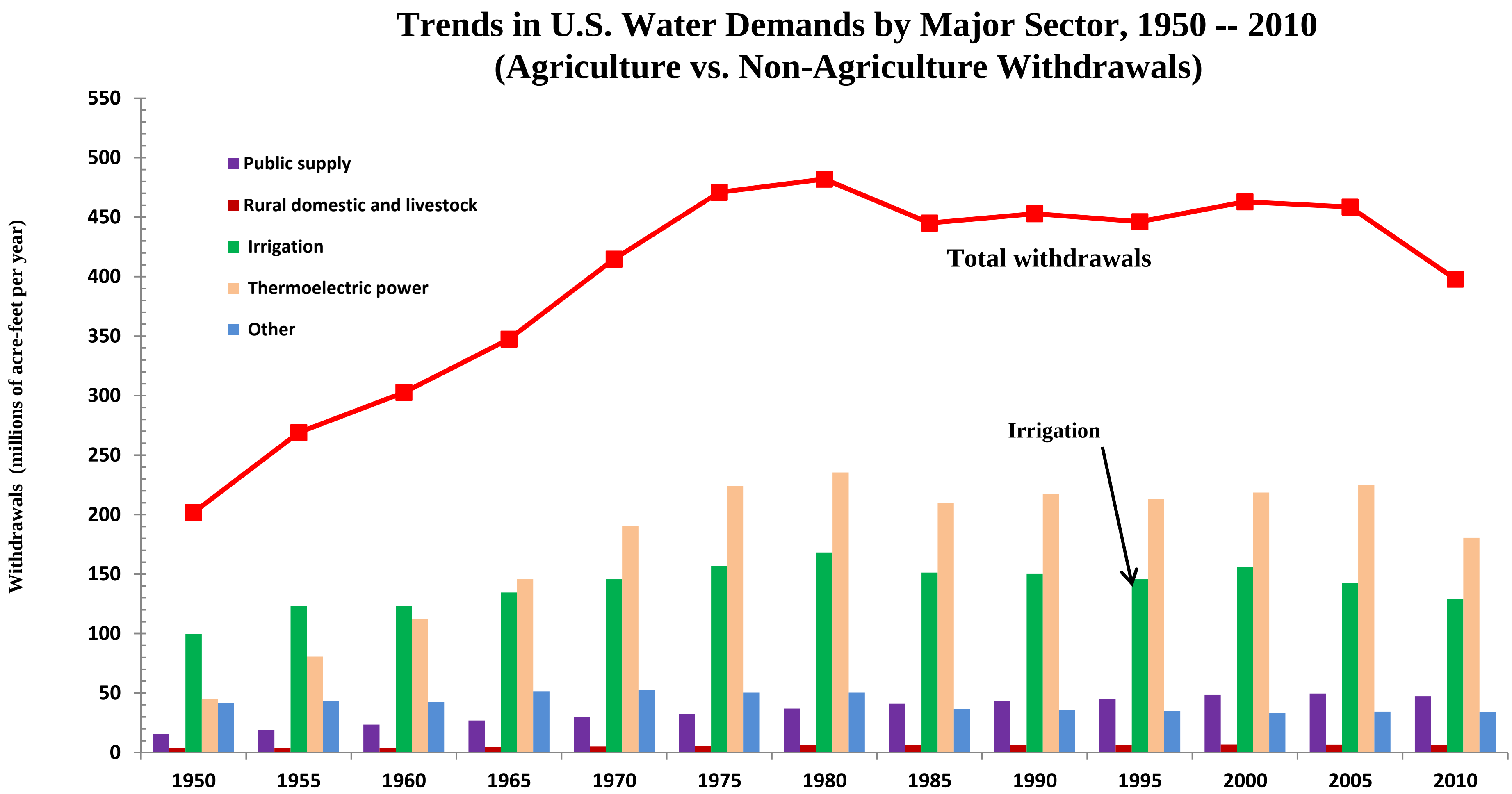


Source: U.S. Climate Data http://www.usclimatedata.com

Variability Matters: The 2012 Drought



Competition Matters: Irrigation over Time



Source: Maupin, M.A., Kenny, J.F., Hutson, S.S., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2014, *Estimated use of water in the United States in 2010*, U.S. Geological Survey, Circular1405, table 14, p. 45, http://dx.doi.org/10.3133/cir1405.

"Other" category includes water use for the self-supplied industrial, mining, commercial, and aquaculture sectors.

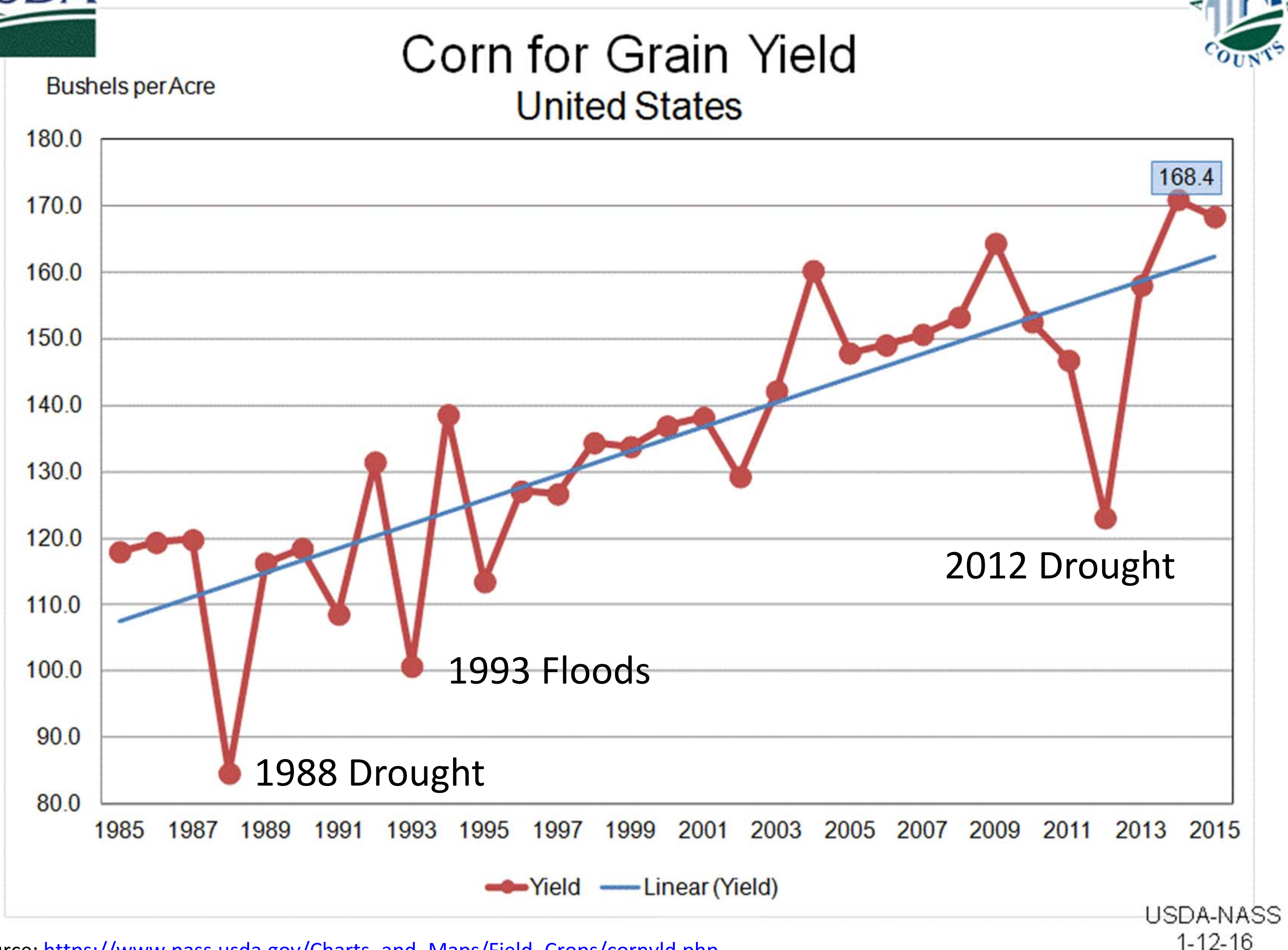
Note: U.S. Geological Survey water use numbers were converted to million acre-feet units.

Source: USGS Water Use in the United States (water.usgs.gov/watuse)

The Significance of Drought

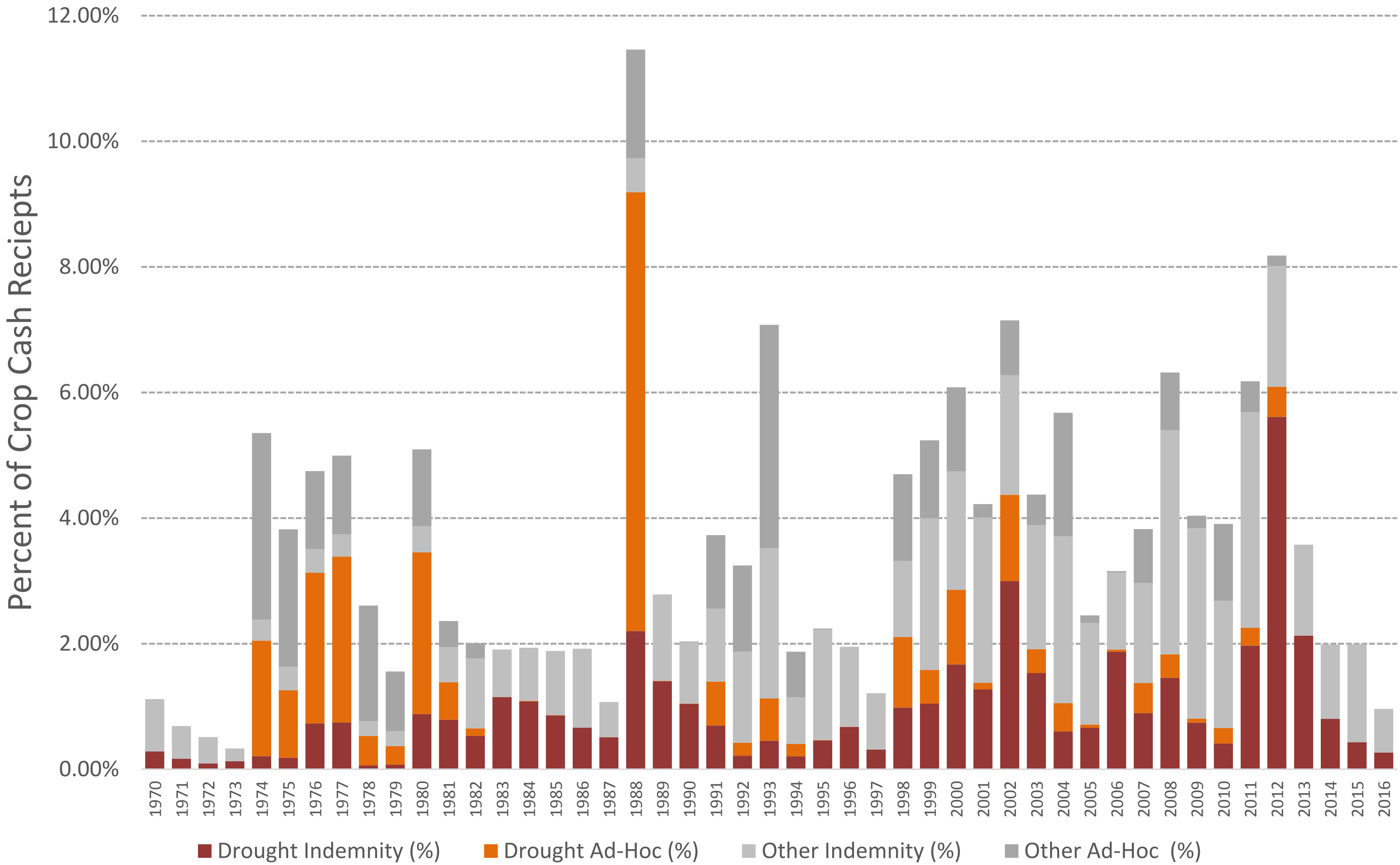
- Drought causes crop and forage yield shocks.
- Drought can causes large income shocks.
- Historically, drought has been linked to major economic disruptions.
- The way that farmers and government programs respond to droughts has changed, and continues to change, over the long run.

Major Droughts are Clearly Evident in National Corn Yields



Source: https://www.nass.usda.gov/Charts_and_Maps/Field_Crops/cornyld.php

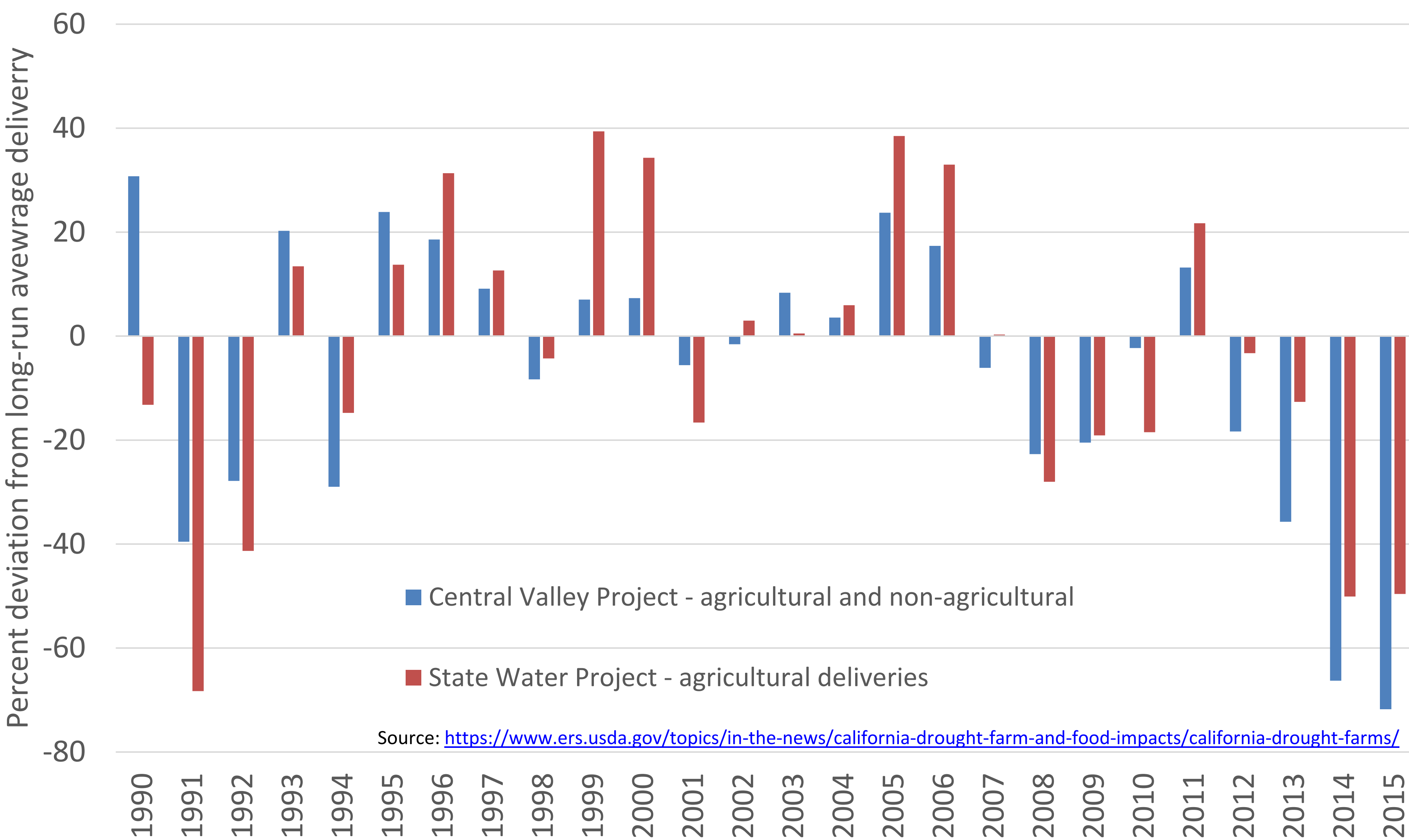
In 1988, Over 9% of Crop Cash Receipts were Drought-Related Assistance or Indemnity



Drought Response

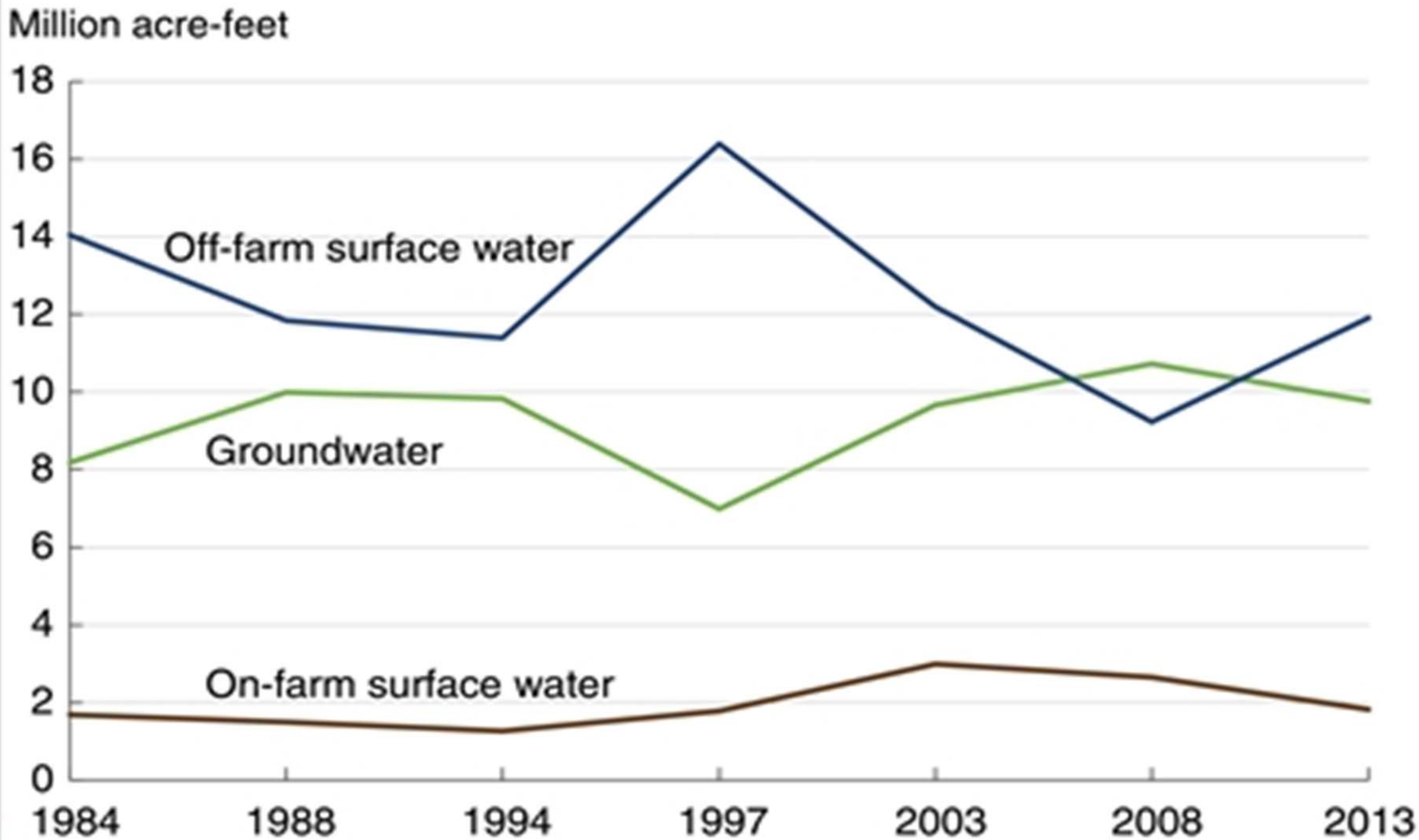
- Commodity markets offset some yield loss through price increases ➔ spreads risk to consumers
- Crop insurance offsets some revenue loss ➔ spreads risk over time through insurance premiums
- Water storage (reservoirs and aquifers) ➔ spreads risk over time

In California, Drought Results in Reductions in Surface Water Deliveries



Groundwater Serves as a Partial Substitute for Reduced Surface Water

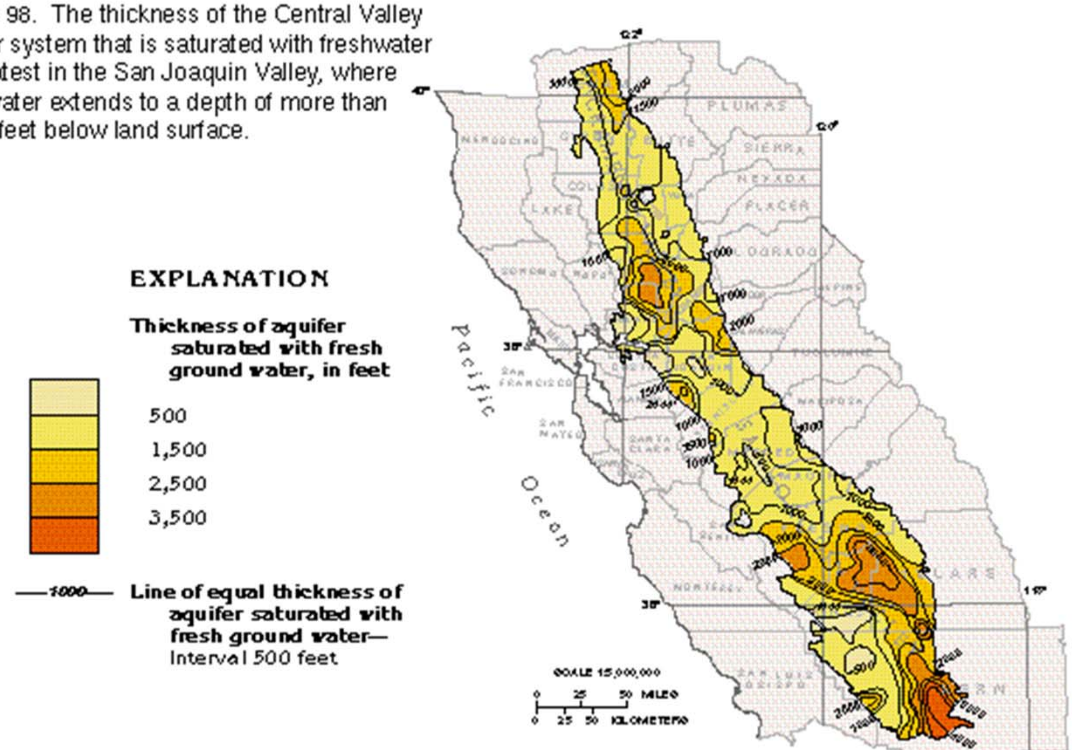
Substitution between groundwater and off-farm surface water for irrigation



Source: USDA Farm and Ranch Irrigation Survey.

Groundwater Overdraft Impacts Some Areas More than Others

Figure 98. The thickness of the Central Valley aquifer system that is saturated with freshwater is greatest in the San Joaquin Valley, where freshwater extends to a depth of more than 4,000 feet below land surface.



Williamson, A.K., Prudic, D.E., and Swain, L.A., 1989, Ground-water flow in the Central Valley, California: U.S. Geological Survey Professional Paper 1401–D, 127 p.

Sources: USGS (http://pubs.usgs.gov/ha/ha730/ch_b/B-text3.html) and Scanlon et al. (2012) (http://www.pnas.org/content/109/24/9320.full.pdf)

Drought Risk Adaptation

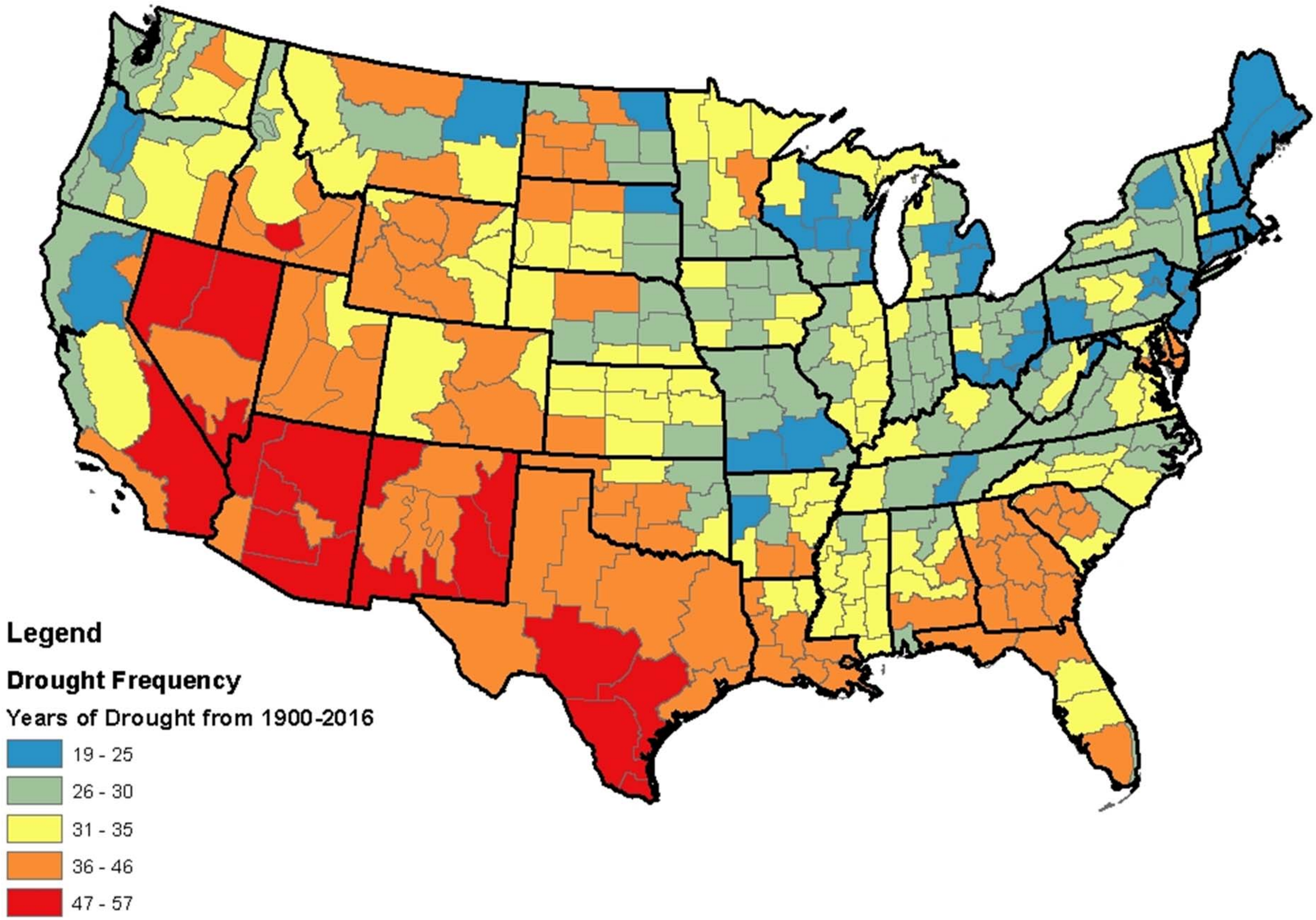
- In addition to short-run response to drought, farmers and policy makers also…

  …simply absorb the shocks (drought impacts)

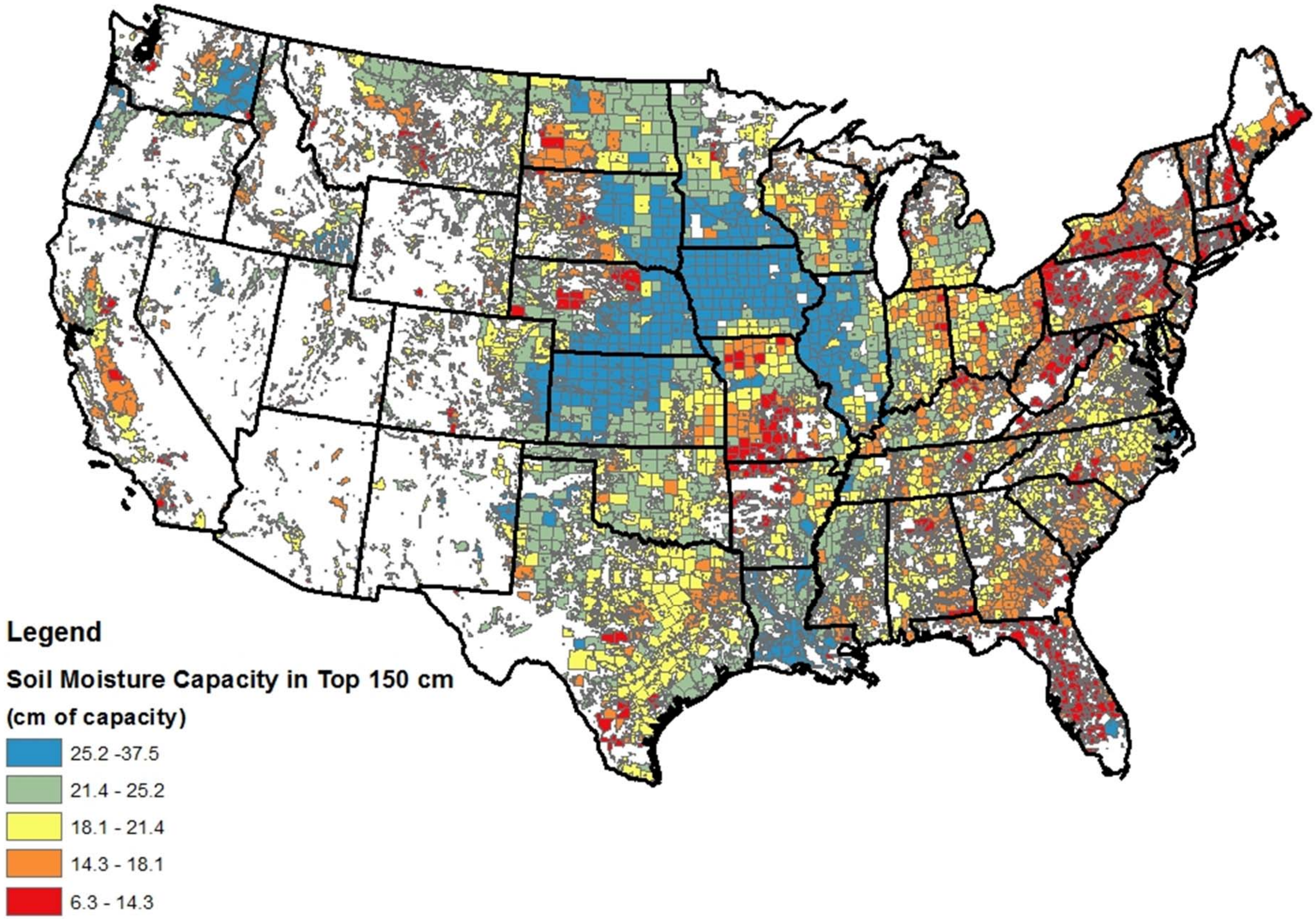
  …take prior action to reduce impacts and response (drought preparedness)

- Since some farmers have more incentives to prepare for drought, we study drought risk adaptation.

Drought "Risk" Reflects Differences in Drought Frequency

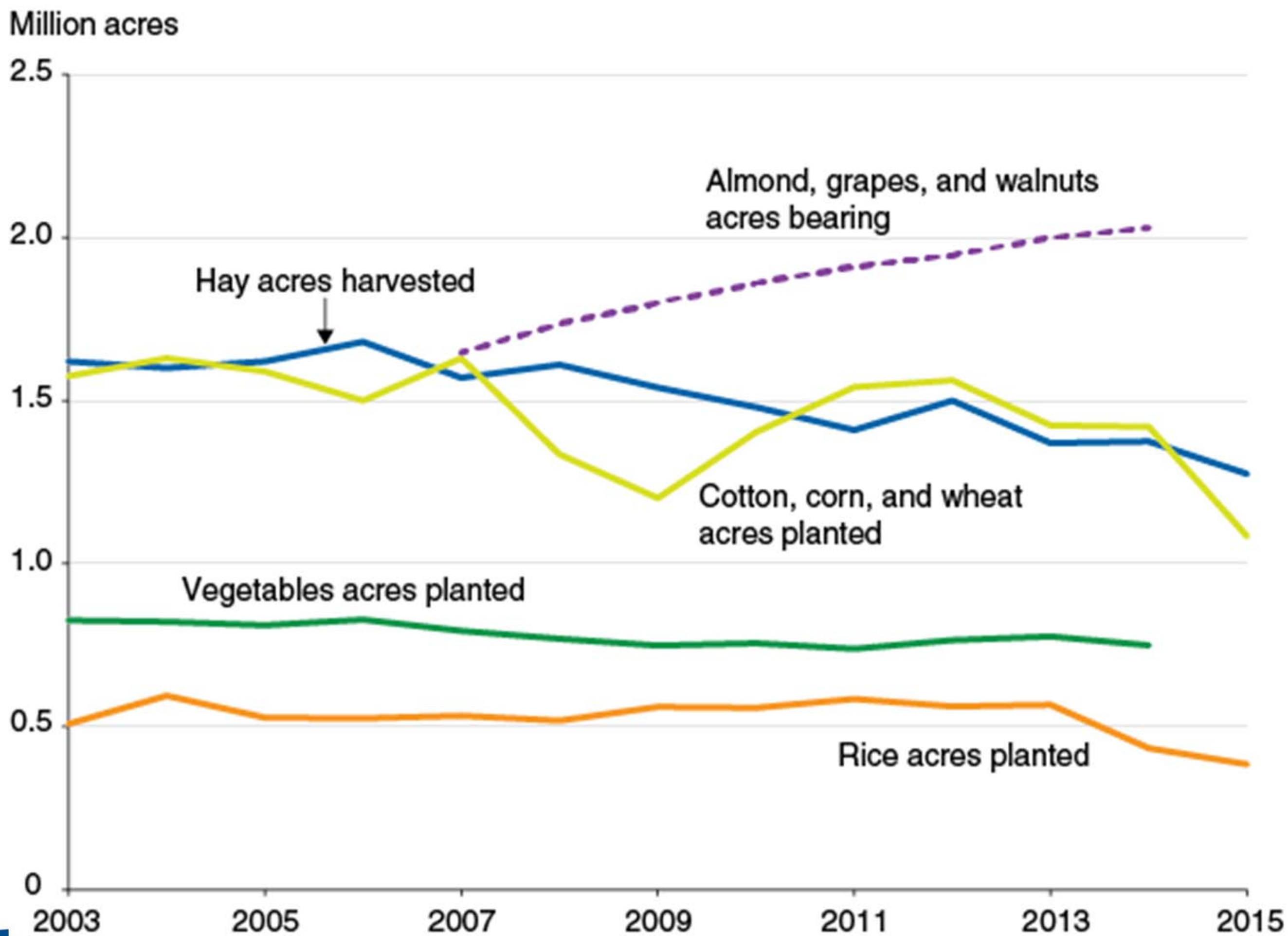


Vulnerability to Drought Risk Depends upon Factors Like Soil Health



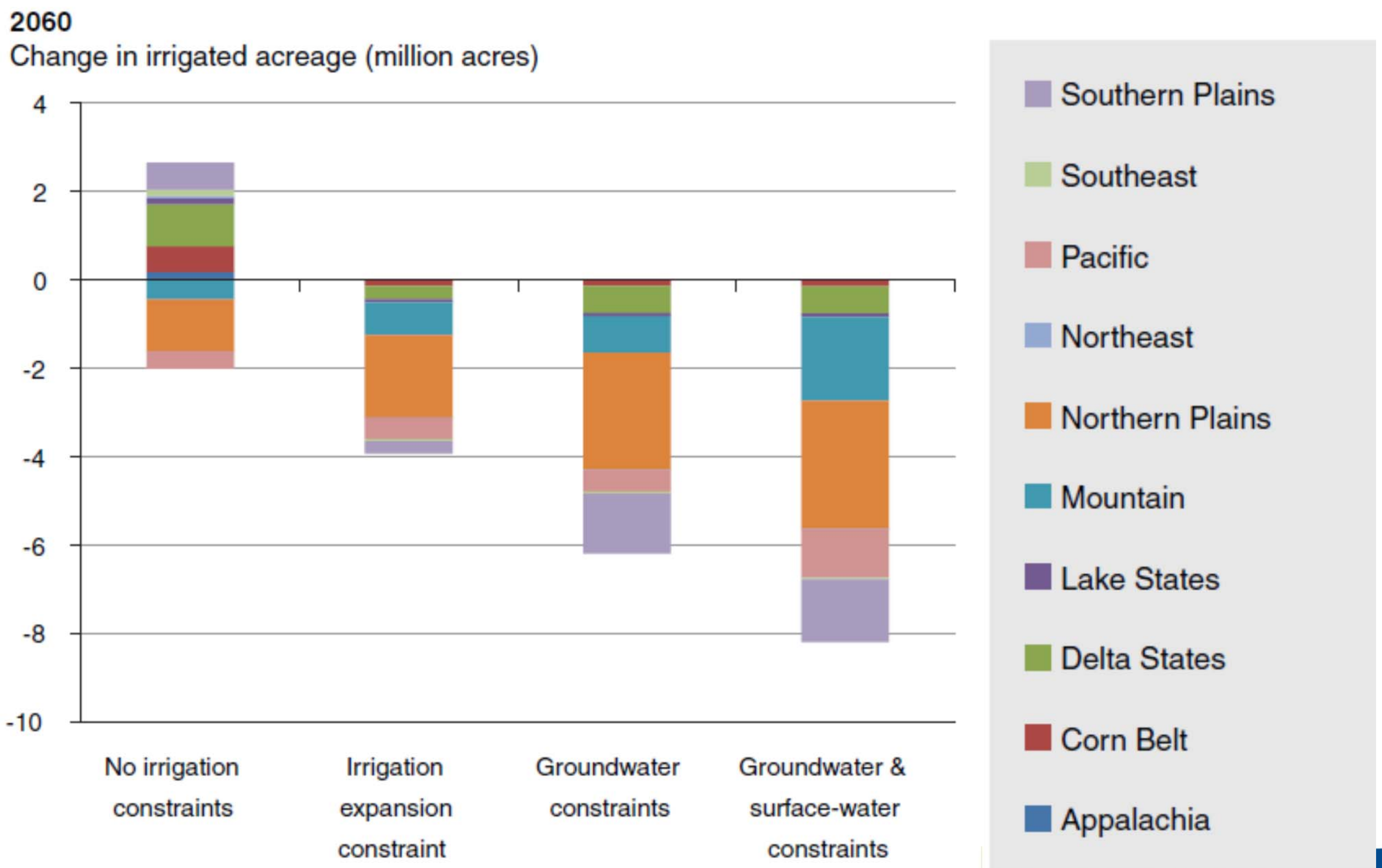
In California, Changes in Crop Acreage Reflect Water Scarcity

Orchard acreage is trending upward in California while other crops are declining



Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service, *QuickStats*.

Simulations of Climate Adaptation Suggest that Water Constraints will Limit Irrigation Expansion



Source: https://www.ers.usda.gov/topics/natural-resources-environment/climate-change/agricultural-impacts-and-adaptation/

Water Scarcity and Farm Programs

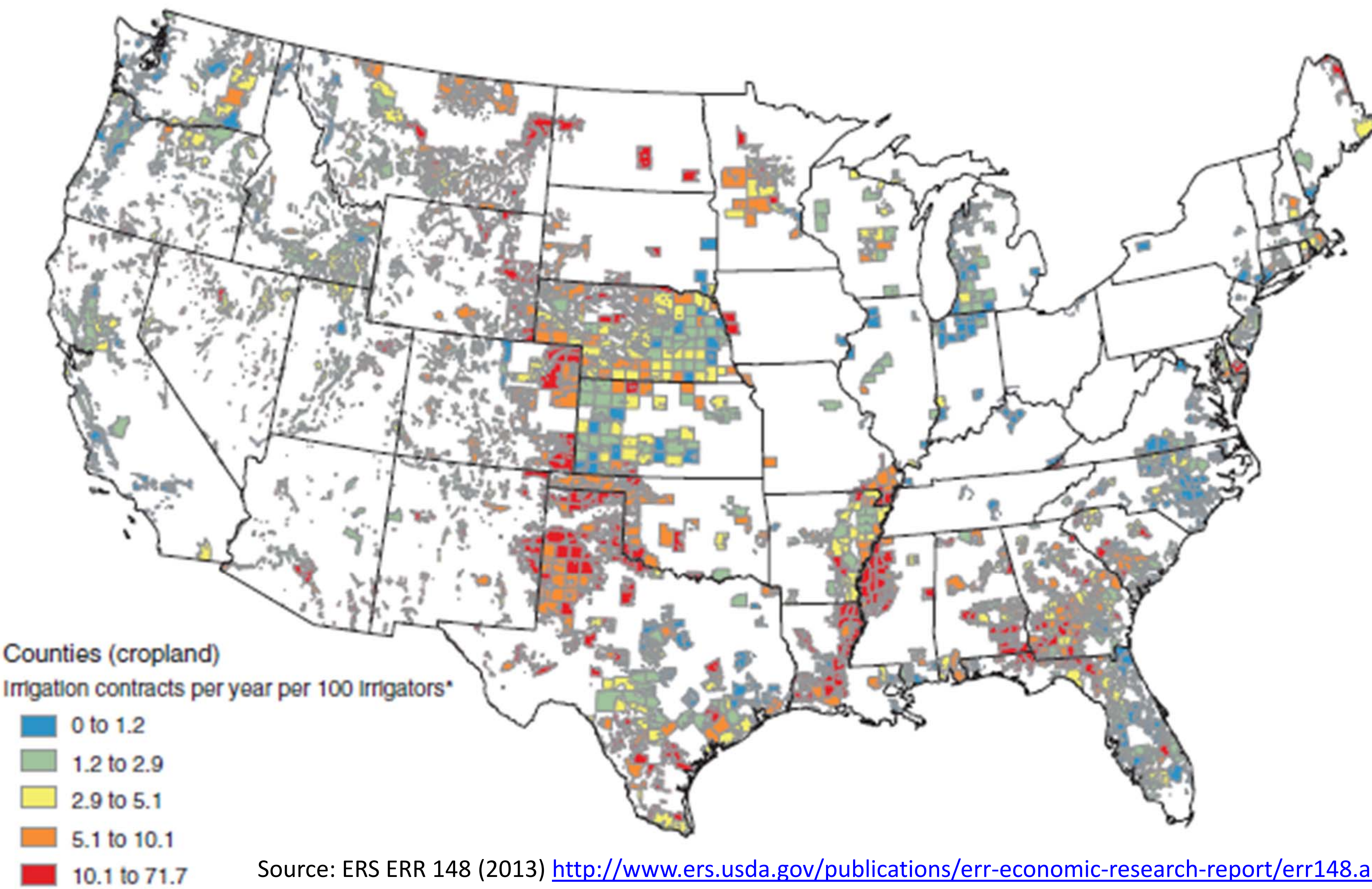
- In addition to the insurance programs, the Farm Act directs USDA to address water scarcity issues:
  - The Regional Conservation Partnership Program purpose: “to further the **conservation,** restoration, and **sustainable use** of soil, **water**, wildlife, and related resources.”
  - The Environmental Quality Incentives Program purpose : “to assist producers…with regulatory requirements concerning…**surface and groundwater conservation**.”

USDA Conservation Programs Are Helping with Drought Risk Adaptation

- Working lands programs
  - Irrigation practices are about 10% or more of historical EQIP funding
  - Irrigation practices more likely in higher risk regions
  - Conservation tillage more likely in higher risk regions
- Conservation Reserve Program
  - Offers to retire are more likely in higher risk regions
  - Haying and grazing provision usage increased in 2012

Irrigators’ Enrollment in EQIP is More Common in Areas Facing Higher Drought Risk

Irrigation-related Environmental Quality Incentives Program participation rates by county, 2002-10



Source: ERS ERR 148 (2013) http://www.ers.usda.gov/publications/err-economic-research-report/err148.aspx

Conclusions

- Farmers face many types of water scarcity.
- Variability - drought risk - is an important type of water scarcity.
- Farmers adapt to drought risk through a variety of mechanisms – crop insurance, irrigation, crop choice, and soil health.
- Voluntary farm programs such as conservation programs play a role in assisting drought risk adaptation.