Water Scarcity and Farmer Adaptation

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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
Trends in U.S. Water Demands by Major Sector, 1950 -- 2010
(Agriculture vs. Non-Agriculture Withdrawals)


"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)
• Drought causes crop and forage yield shocks.  
• Drought can cause 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

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

- Off-farm surface water
- Groundwater
- On-farm surface water

Source: USDA Farm and Ranch Irrigation Survey.
Groundwater Overdraft Impacts Some Areas More than Others

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)
• 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

Legend

Drought Frequency
Years of Drought from 1900-2016

- 19 - 25
- 26 - 30
- 31 - 35
- 36 - 46
- 47 - 57
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.

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

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

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.