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# CLIMATE CHANGE AND THE AGRICULTURAL ECONOMY



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Agricultural Outlook Forum  
February 24, 2012

Photos courtesy of USDA/ARS

# AGRICULTURE & ADAPTATION



Scott Bauer

Agroecosystems



Cropping Systems



Photo supplied by Geovantage, Inc.

Farming Systems



Keith Weller

Plant Systems



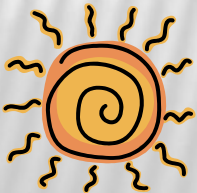
International Markets



Domestic Markets

# ECONOMIC IMPACT ASSESSMENT

- × Economic impact estimates are sensitive to a number of research elements:
  - + **Scope of the Assessment**
    - × Adaptation Opportunities and Constraints
  - + **Climate and Yield Projections (and associated time horizon)**
  - + **Methodology Used, Model Specification**



# SCOPE: ADAPTATION OPTIONS

## FARM PRODUCTION PRACTICES

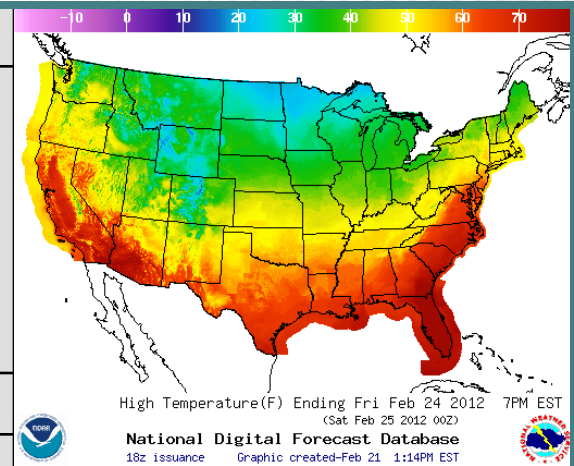
- Diversify crop and livestock types and varieties
- Change the intensification of production
- Use alternative fallow and tillage practices
- Implement irrigation practices
- Change timing of farm operations

## TECHNOLOGICAL DEVELOPMENTS

- Develop new crop varieties
- Develop early warning systems that provide daily weather predictions and seasonal forecasts
- Develop water management innovations
- Develop farm-level resource management innovations

## FARM FINANCIAL MANAGEMENT

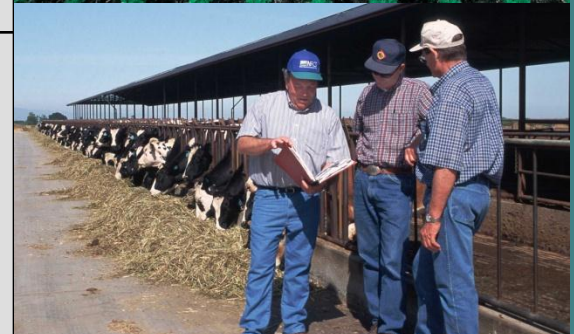
- Purchase crop insurance to reduce the risks of climate-related income loss
- Invest in crop shares and futures to reduce the risks of climate-related income loss
- Diversify source of household income



Map courtesy of NOAA



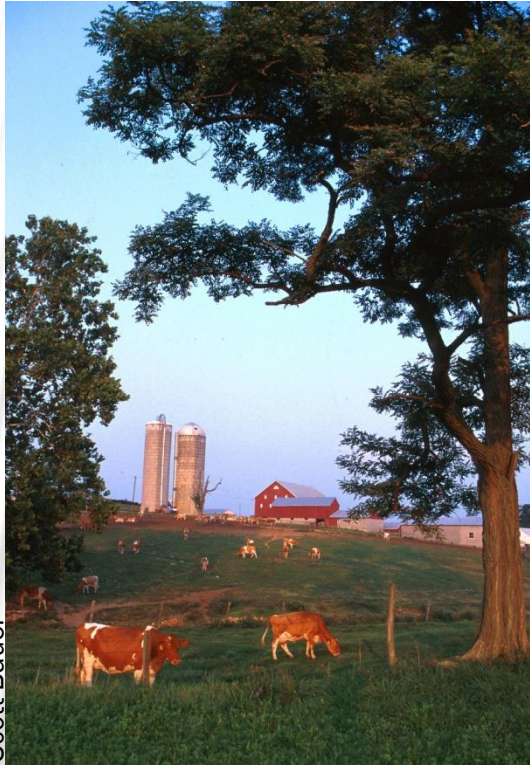
Photos courtesy of NRCS/Lynn Betts



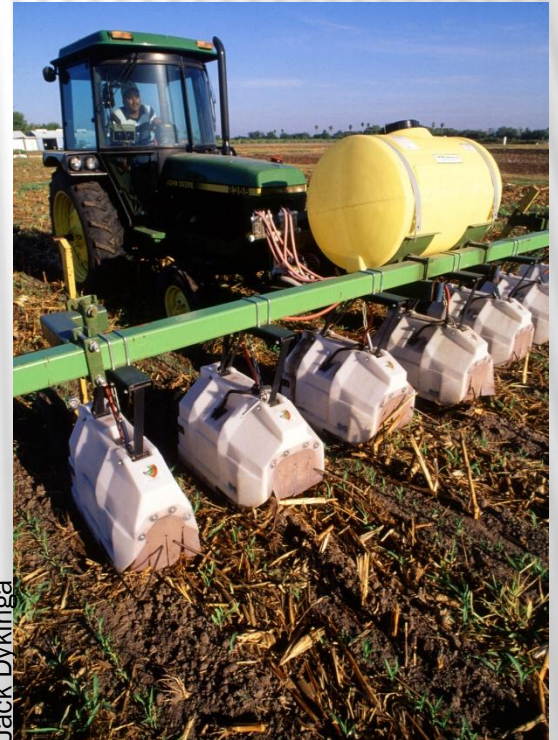
# SCOPE: ADAPTATION CONSTRAINTS



Doug Wilson

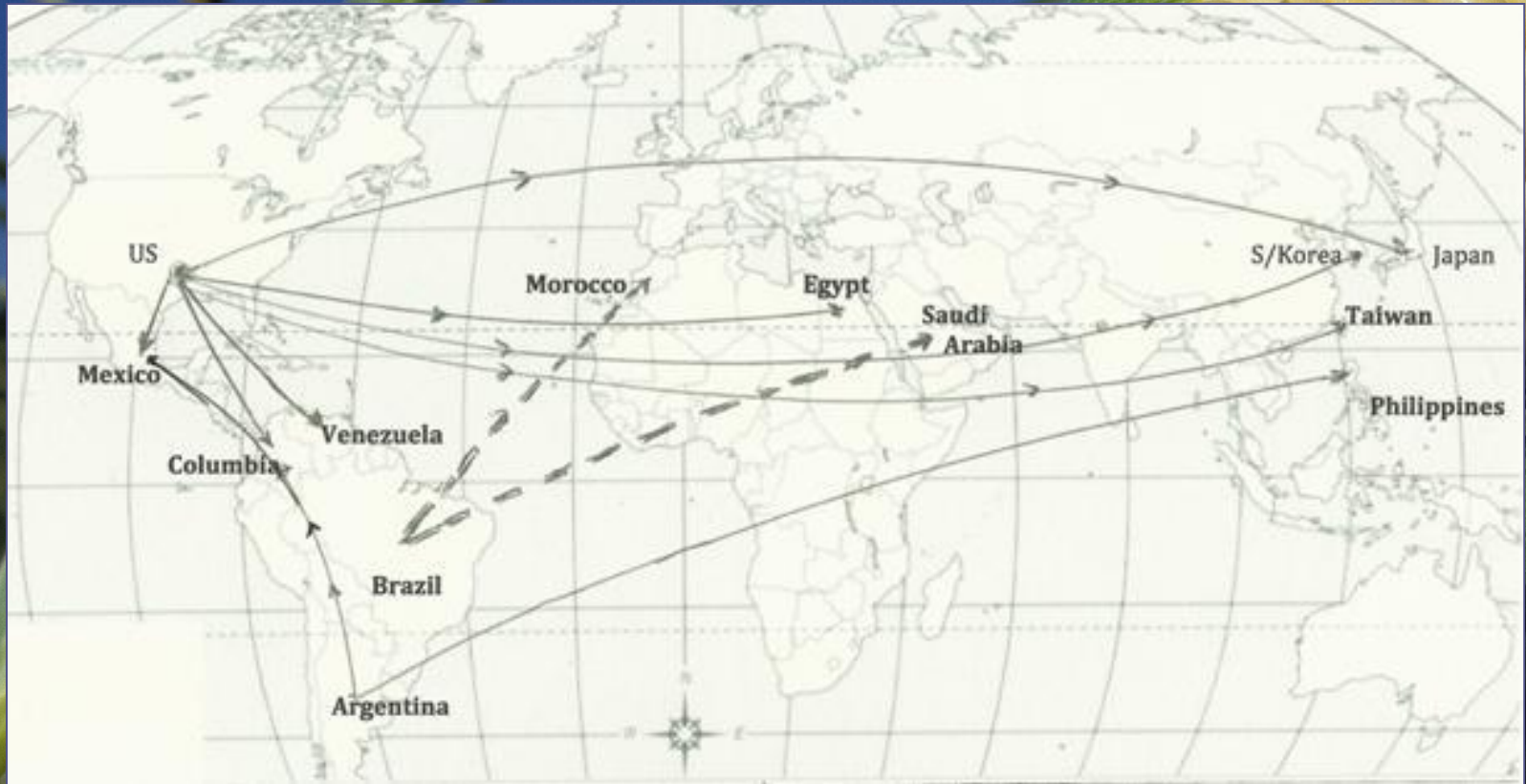


Scott Bauer



Jack Dykinga

# SCOPE: TRADE EFFECTS



Source: UNCTAD

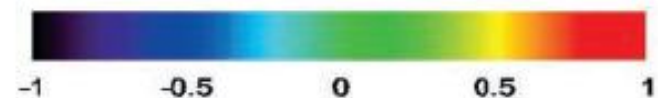
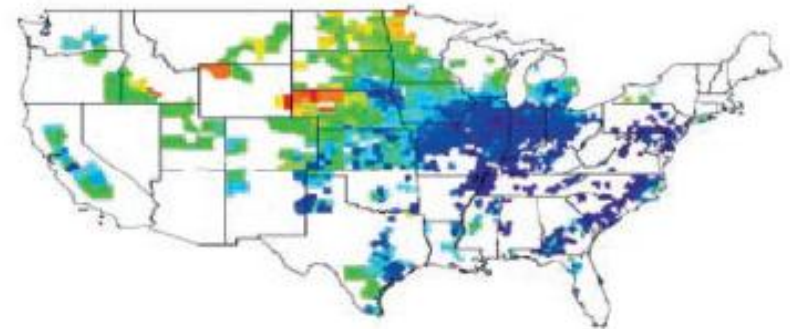
## Trade Flows for Corn

Photo courtesy of USDA/ARS, Doug Wilson

# CLIMATE AND YIELD PROJECTIONS

- ✘ Several studies have underlying yield assumptions broadly consistent with the IPCC (2007) findings:
  - + “moderate climate change will likely increase yields of North American rain-fed agriculture”
  - + Crop productivity is projected to increase slightly at mid- to high latitudes for local mean temperature increases of up to 1 to 3 °C, and then decrease beyond that.
- ✘ Some studies not consistent with IPCC findings:
  - + Kucharik and Serbin, 2008
  - + Lobell and Asner, 2003

Temperature/yield correlation for corn



Source: Lobell and Asner, 2003

# EXTREME EVENTS

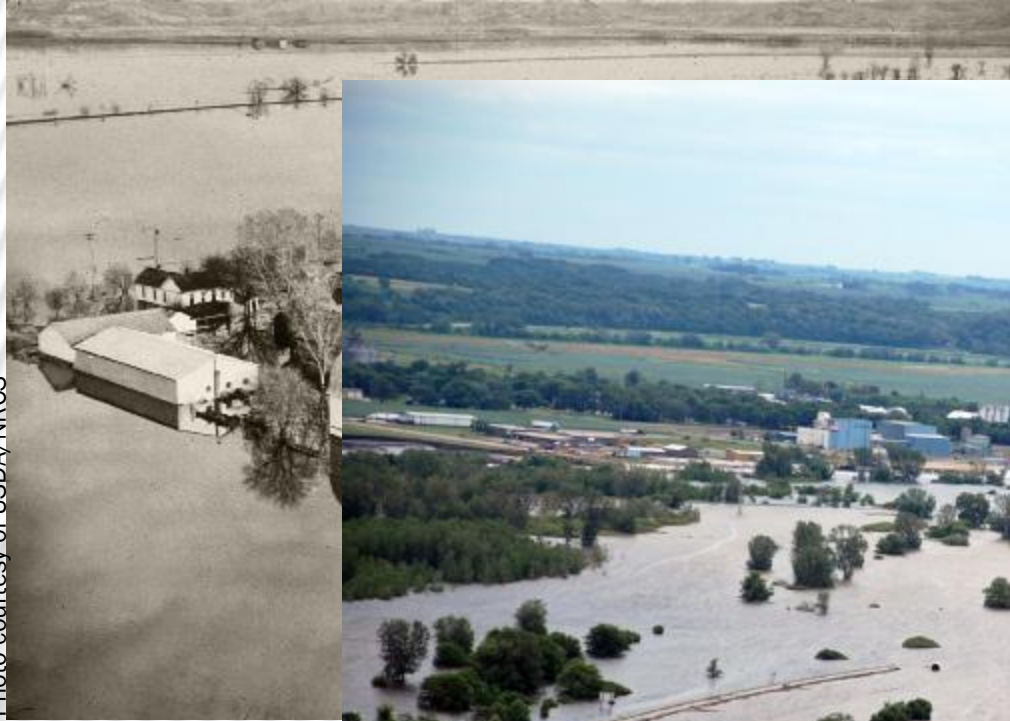


Photo courtesy of USDA/NRCS



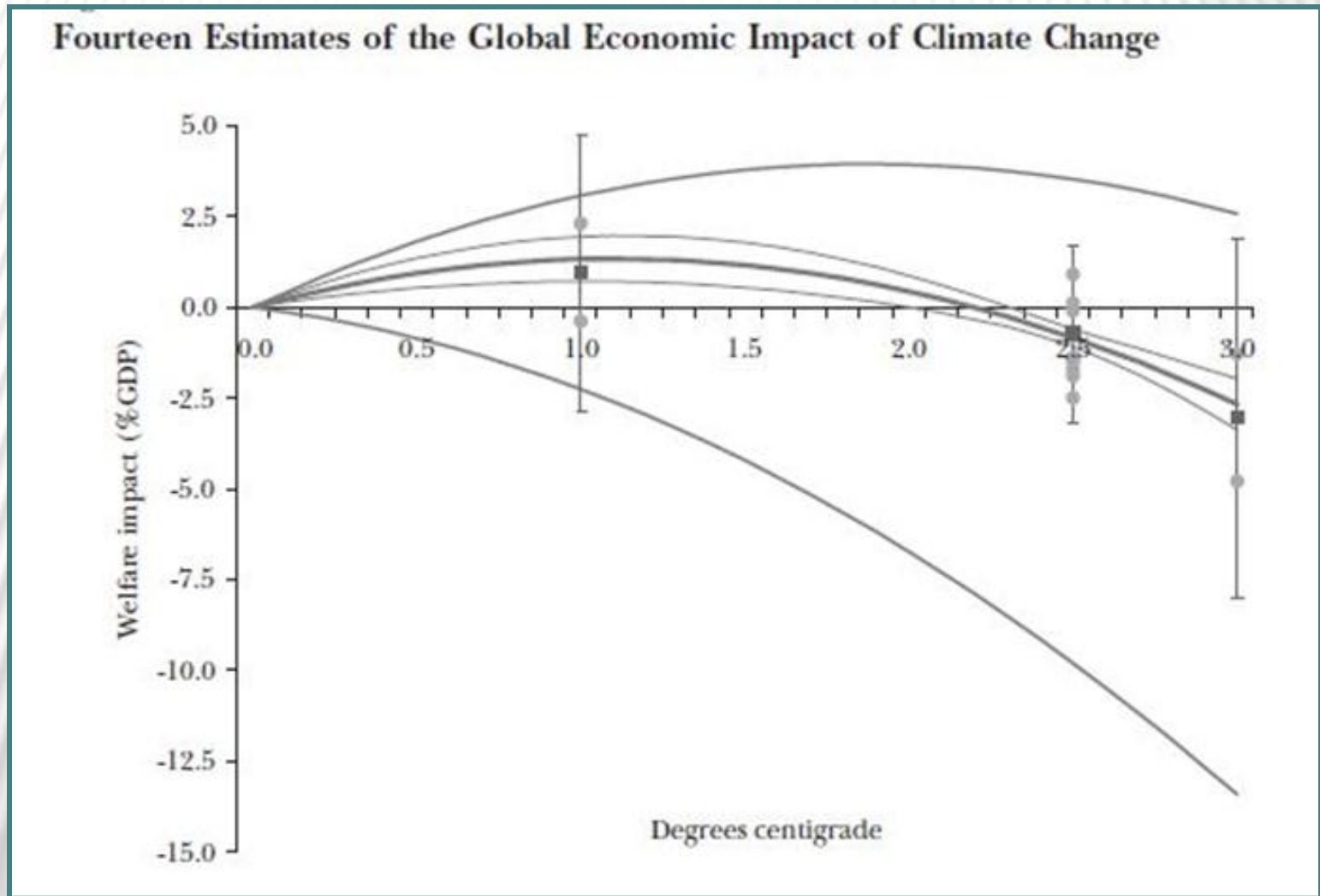
Photo courtesy of Trace Anderson, FEMA



Photo courtesy of USDA/NRCS

Study	Year/ Time Frame	Climate Model/ Scenario	Consumer Welfare	Producer Welfare	Total U.S. Welfare Impact	CO2 Impacts
Adams et al 1990	Mid-century	NASA/ GISS	↑	↑	↑	✓
Adams et al 1990	Mid-century	GFDL	↓	↑	↓	✓
Adams et al 1995	Mid-century	NASA/ GISS	↓	↑	↓	
Adams et al 1995	Mid-century	NASA/ GISS	↓	↑	↑	✓
Alig et al 2002	2070- 2100	Hadley	↑	↓	↑	✓
Reilly et al 2003	2090	Hadley	↑	↓	↑	✓
Sands et al 2005	Mid-century	UIUC/ Univ. IL, UC	↓	↓	↓	
Sands et al 2005	Mid-century	UIUC/ Univ. IL, UC	↑	↑	↑	✓
Deschenes et al 2007		+5° F +8% Precip		↑		
McCarl et al, 2008	2030	Canadian	↑	↓	↑	✓
McCarl et al, 2008	2030	CSIRO	↑	↓	↓	✓

# GLOBAL GDP IMPACT ESTIMATES

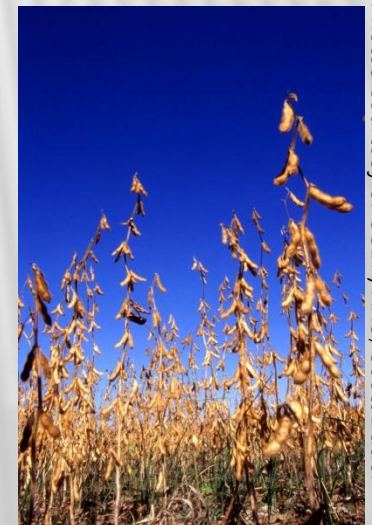


Source: Tol, 2009

# U.S. FARM RETURN IMPACTS (\$MILLIONS/YEAR)

Clim. Scen. →	ECH	CSIRO	CNR	MIROC
<b>Corn Belt</b>	-1114	-2165	-2112	-4053
<b>Delta</b>	904	167	-521	-146
<b>Lake States</b>	41	902	1001	-37
<b>N. Plains</b>	1256	1671	-914	255
<b>S. Plains</b>	418	322	7	681
<b>US</b>	3619	2165	-332	-1465

	ECH	CSIRO	CNR	MIROC
<b>Corn</b>	-742	-839	-33	-223
<b>Wheat</b>	-10	332	-265	-456
<b>Soybeans</b>	1361	-180	-2772	-3412
<b>Cotton</b>	1135	1081	1474	1266



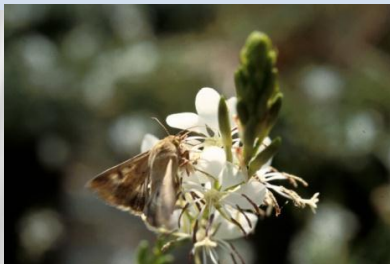
Photos courtesy of USDA/ARS, Scott Bauer

Source: Malcolm et al, USDA/ERS, 2011

# ADDITIONAL IMPACTS DUE TO PEST DAMAGE

- Changes in returns to crop production (\$ millions/year)

Climate Scen. →	<b>ECH</b>	<b>CSIRO</b>	<b>CNR</b>	<b>MIROC</b>
<b>US (no pests)</b>	<b>3619</b>	<b>2165</b>	<b>-332</b>	<b>-1465</b>
<b>US</b>	<b>-4997</b>	<b>-2256</b>	<b>-2434</b>	<b>26</b>
<b>Corn Belt</b>	<b>-2544</b>	<b>-1560</b>	<b>-1494</b>	<b>-116</b>
<b>Delta</b>	<b>-180</b>	<b>-46</b>	<b>16</b>	<b>-67</b>
<b>Lake States</b>	<b>-708</b>	<b>-337</b>	<b>-569</b>	<b>-417</b>
<b>N. Plains</b>	<b>-652</b>	<b>-79</b>	<b>-311</b>	<b>164</b>
<b>S. Plains</b>	<b>-157</b>	<b>41</b>	<b>163</b>	<b>473</b>



Juan Lopez



Source: Malcolm et al, USDA/ERS, 2011

# GENERAL CONCLUSIONS

- ✘ In the short term, existing adaptation strategies will provide substantial adaptive capacity
  - + Some estimates point to initial benefits of a modest increase in temperature, followed by losses as temperatures increase further
  - + No consensus on likely domestic yield responses
  - + International impacts will be more significant
- ✘ A failure to consider management costs for biotic stressors may overstate farms' financial viability in the face of changing climate conditions
- ✘ Economic impacts are variable across regions and stakeholders



# GENERAL CONCLUSIONS

- × Impacts of climate change in the United States will depend on impacts and adaptation opportunities worldwide
  - + Producer and consumer impacts highly sensitive to market-mediated price impacts
  - + Negative global yield impacts can drive global prices up
    - × Downward pressure on U.S. consumer welfare
    - × Upward pressure on U.S. producer welfare
  - + Positive global yield impacts can lower world and domestic prices
    - × Downward pressure on U.S. producer welfare
    - × Upward pressure on U.S. consumer welfare



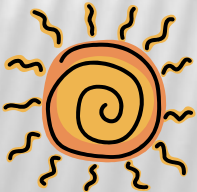
Photo courtesy of USDA/ARS, David Nance

# RESEARCH NEEDS

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- × Underlying science

- + Precipitation and hydrological balance projections
- + Carbon fertilization
- + Biotic as well as abiotic stressors
- + Climate variability and incidence of climate extremes
  - × The impacts on crop yields and farm finances



# RESEARCH NEEDS (CONT.)

- ✘ Better understanding and treatment of uncertainty in projections
  - + Explicit risk assessment framework
- ✘ Improved understanding of the opportunities and constraints for economic and adaptive behavior
  - + technology, finance, policy, information, and resource limitations

