Adapting and Managing for Climate Extremes

Can Agriculture Cope?
Contact Information

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- Precipitation changes
- Temperature changes
- Moving toward extremes

Climate Change
Observed U.S. Trends in Heavy Precipitation

The chart shows the relative number of extreme events (in %) across different decades from the 1900s to the 2000s. The y-axis represents the relative number of extreme events, ranging from -40% to 40%. The x-axis represents the decades: 1900s, 1910s, 1920s, 1930s, 1940s, 1950s, 1960s, 1970s, 1980s, 1990s, and 2000s. The data indicates an increasing trend in heavy precipitation events from the 1900s to the 2000s.
Observed Change in Very Heavy Precipitation
Increasing Heavy Downpours in Iowa
The increase in spring precipitation has decreased the number of workable field days in April through mid-May across Iowa by 3.7 in 1995 to 2010 compared to 1979-1994.
Suitable Field Days (Apr 2 - Jun 3) versus April-May Rainfall, Iowa Average (1959-2013)

\[ y = -2.5991x + 54.048 \]

\[ R^2 = 0.45023 \]
Projected Precipitation Change by Season

Higher Emissions (A2)

- Winter
- Spring
- Summer
- Fall

Precipitation Change (%)

-30 -20 -10 0 10 20 30
Temperature Change by Decade

- 2001-2012 even warmer. Every year warmer than 1990s average.
- 1990s even warmer. Every year warmer than 1980s average.
- 1980s warmest decade on record at the time.
Observed U.S. Temperature Change
Observed Increases in Frost-Free Season

Change in Annual Number of Days

- 0-4
- 5-9
- 10-14
- 15+

+16
+19
+10
+9
+6
+10
Projected Temperature Change

Lower Emissions (B1)  

Higher Emissions (A2)  

Temperature Change (°F)

3 4 5 6 7 8 9 10 15
Temperature Effects on Evaporation

\[ ET = \frac{\rho c_p (T_0 - T_s)}{r_a} + \frac{\rho c_p [e_s(T_0) - e_a]}{\gamma(1 + \frac{r_s}{r_a})r_a} \]

- **Temperature Effects on Evaporation**: The diagram shows the relationship between air temperature (C) and saturation vapor pressure (kPa). The equation for saturation vapor pressure is given by: \( e^* = 0.61121 \exp(17.502 \frac{T_a}{T_a} + 240.97) \).
Mean Summer (JJA) Dew-Point Temperatures for Des Moines, IA

Rise of 3°F in 42 years
12% rise in atmospheric water content in 42 years
Weather Trend: Unusual combinations of spring and summer rainfall are occurring more often.

Spring and Summer Rainfall In Iowa (1893-2013)
1-in-20-yr return in 1893-1980 has 1-in-4-yr return in 1981-2013

95th Percentile

Data Source: State of Iowa Climatologist
Midwest Agriculture

- Intense agriculture and extensive agriculture
Corn (53,000,000 acres)
Soybean (44,000,000 acres)
Wheat, alfalfa, asparagus, cabbage, carrots, cucumbers, onions, peas, bell peppers, potatoes, sweet corn, tobacco, tomatoes, watermelon
Apples, blueberries, sweet cherries, tart cherries, peaches, plums, raspberries, strawberries
Pastureland (16,000,000 acres used for grazing and forage)
Current Agriculture in the Midwest

Midwest Corn Grain Production

Midwest Soybean Production

Midwest Sweet Corn Production

Midwest Potato Production
# Midwest Livestock

<table>
<thead>
<tr>
<th>Commodity</th>
<th>2012 Numbers</th>
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<tbody>
<tr>
<td>Cattle and calves</td>
<td>17,825,236</td>
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<tr>
<td>Dairy</td>
<td>5,695,982</td>
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<tr>
<td>Hogs</td>
<td>42,684,828</td>
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<td>Layers</td>
<td>146,506,736</td>
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<td>Broilers</td>
<td>84,087,693</td>
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<td>Turkeys</td>
<td>44,985,526</td>
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</tbody>
</table>
Temperature Responses

[Diagram showing temperature responses and a heat stress chart]

Dairy Heat Stress Chart

Source: University of Arizona

To use this chart: Simply match up the temperature on the vertical scale with the day’s relative humidity on the horizontal scale.
Seasonal changes in precipitation
Increased variation in temperature and precipitation among and within years
Increase in relative humidity during the summer
Increase the temperature and precipitation extremes
Good Soils = Good Yields

Soybean yields across Iowa, Kentucky, and Nebraska

Climate resilience is derived from good soils in rainfed agricultural systems
Will have to couple all aspects of crop and livestock production with climate variation in order to develop effective adaptation strategies

Soil management will be a critical part of climate resilience

Adaptation