C-Quest: The Climate Research Challenge for Agriculture

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What is climate change?

- Change in precipitation
- Change in temperature
- Change in seasonality
- Frequency of extreme events
- Increase variability
Low Pathway (RCP 2.6)

High Pathway (RCP 8.5)

Degrees F

1  3  5  7  9  11  13  15

Generally, Wet Get Wetter and Dry Get Drier

Low Pathway (RCP 2.6)

High Pathway (RCP 8.5)

Percent Change

-30  -20  -10  0  10  20  30
Future Climates: Episodes of Extreme Events

Higher Mean Temperature

More Episodes of High Temperatures

Higher Mean Temperature and More Episodes of High Temperatures
Pattern of Projected Changes in Soil Moisture

Mid-Century Changes

End-of-Century Changes

Higher Emissions Scenario (A2)

Lower Emissions Scenario (B1)

Percent

-15 -10 -5 -1 1 5 10 15
Lal et al., 2012. J. Soil Water Conserv. 67
Heat and drought stress are major environmental concerns.

Year 2011: Kansas – $ 1.8 billion (insurance claims); Texas (about $ 5 billion). Most yield losses were related to drought and high temperatures.

### Economic Impact of Drought and Heat Stress

<table>
<thead>
<tr>
<th>Crops</th>
<th>Crop Grain Yield Loss (million)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
</tr>
<tr>
<td>1. Wheat</td>
<td>$ 286</td>
</tr>
<tr>
<td>2. Sorghum</td>
<td>$ 214</td>
</tr>
<tr>
<td>3. Corn</td>
<td>$ 966</td>
</tr>
<tr>
<td>4. Soybean</td>
<td>$ 310</td>
</tr>
</tbody>
</table>

Research Needed
Research

• Soil Health
  – Provides resilience
  – Soil biology
Research to adapt to climate variability

• Erosion prevention and protection from extreme weather events, which may be more damaging in the future.

• Increase soil C sequestration to improve soil health.

• More diverse cropping systems to adapt to variable climates and new pest and disease pressures.

• Improve the synchronization of planting and harvesting operations with shifts in the hydrologic cycle (rainy season

Delgado et al, 2011; J. Soil Water Consn, Vol 66 - Best paper award
No-till Cropping Systems

- Restores soil carbon
- Conserves moisture
- Planting flexibility
- Reduces erosion
- Controls weed
- Improves soil fertility
- Saves fuel
- Saves labor
- Lowers machinery costs
Intense and diverse cropping systems

- Soybean
- Oats
- Wheat
- Corn
Managing the Landscape

Riparian

Trees

Grass Buffers
Research

- Plant and animal breeding
- Crop selection
Research to adapt to climate variability

- Develop crop varieties that are:
  - Greater tolerance to drought
  - Greater resistant to heat stress
  - Higher N-use and other nutrient efficiencies
  - Greater synergies with soil microbes
  - Perennials

- Develop livestock breeds for:
  - Greater efficiency and lower emissions
  - Heat tolerance

Delgado et al, 2011; J. Soil Water Consn, Vol
Research

- Sensors
  - Fertilizer management
  - Water management
  - Pest management
- Precision Agriculture
Research to adapt to climate variability

- Manage soil and crops to increase water-use efficiencies.

- Irrigation infrastructure to reduce water losses and increase irrigation efficiencies.

- Increase N-use and other nutrient efficiencies for cropping systems.

- Apply the concepts of precision/target conservation to increase conservation effectiveness across spatial and temporal variability.
Research

- Models and weather forecasting
- Risk Management
Massively exciting, transformational science

A complementary bottom-up approach: Information from commercial fields - Taking advantage of modern information technologies !!!

"The most magical aspect of big data is Smart Data: the application of statistical analytics and machine learning to data sets to find interesting connections and signals in all the noise."

Philip Brittan. http://tmsnrt.rs/1EmFXTT
Temperatura máxima (C)  Precipitación (mm)

<table>
<thead>
<tr>
<th>Historical average</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>76</td>
<td>116</td>
</tr>
</tbody>
</table>

Maximum Temperature (°C)  Precipitation (mm)

Historical average

Forecast
Fedearroz 733: 6.860 kg/ha
Fedearroz 60: 4.600 kg/ha
Challenges

- Collaborate across sciences and with other disciplines to achieve societal challenges and sustainability
  - Agricultural scientists should look for ways to enhance collaboration and integration with
    - Ecology
    - Geostatistics
    - Earth and Planetary Sciences
    - Hydrology
    - Computer Science
    - GIS and Remote Sensing
    - Mathematics and Statistics

- Collaborations with social scientists and economists will help better understand and predict land use changes and human behavior.
Research Summary

- Soil health
  - Provides resilience
  - Soil biology and its interaction with roots
- Plant and animal breeding
- Crop selection
- Sensors
  - Fertilizer management
  - Water management
  - Pest management
- Precision agriculture
- Models and weather forecasting
- Risk management
Summary

• Use all the tools in the tool box
  – Traditional
    • Soil health, soil and crop management
  – Modern Technologies
    • Genetic modifications, remote sensing, precision ag, soil biology

• Provide technical support
  – Extension Land Grant Universities
  – Government
  – Private

• Investments in research and education