

Climate Change and The Risks to Agriculture

Ray Motha

USDA

Chief Meteorologist

U.S. Agriculture

- The US is a major supplier of food and fiber for the world, accounting for up to 25% of the total global trade in wheat, corn, soybeans ,and cotton.
- Cropland currently occupies over 160 million hectares, or 17% of the total US land area.
- In addition, grasslands, and permanent grazing and pasturelands, occupy over 240 million hectares, another 26% of US land area.

U.S. Agriculture

Issues of major environmental concern include:

- Efforts to control soil erosion, agricultural chemicals, and livestock wastes;
- New pests and diseases, the development of sustainable agriculture, and adaptation strategies;
- The impact of extreme weather and climate events such as droughts, heat waves and floods on productivity.
- How future changes in climate will interact with all of the above factors.

Gulf of Mexico “Dead Zone”

- Each year a swath of the Gulf of Mexico becomes so devoid of shrimp, fish, and other marine life that it is known as the dead zone.
- The dead zone is the result of oxygen-depleted water, and at its peak, covers about 13,000 to 21,000 square kilometers.
- The phenomenon is triggered by excessive agricultural fertilizers in the Mississippi River drainage basin streaming into the Gulf of Mexico along the Louisiana coast.
- The river basin drains about 40 percent of all U.S. land area and accounts for nearly 90 percent of the freshwater runoff into the Gulf of Mexico.

Sustainable Agriculture

- Major studies were undertaken in the Midwestern corn/soybean belt to demonstrate to farmers both the urgency and feasibility of sustainable agriculture practices in since the 1980s.
- Fifteen-year results from the Rodale Institute in the US showed that after a transition period with lower yields, the organic systems were competitive financially with the conventional system.

Sustainable Agriculture

“Success Story?”

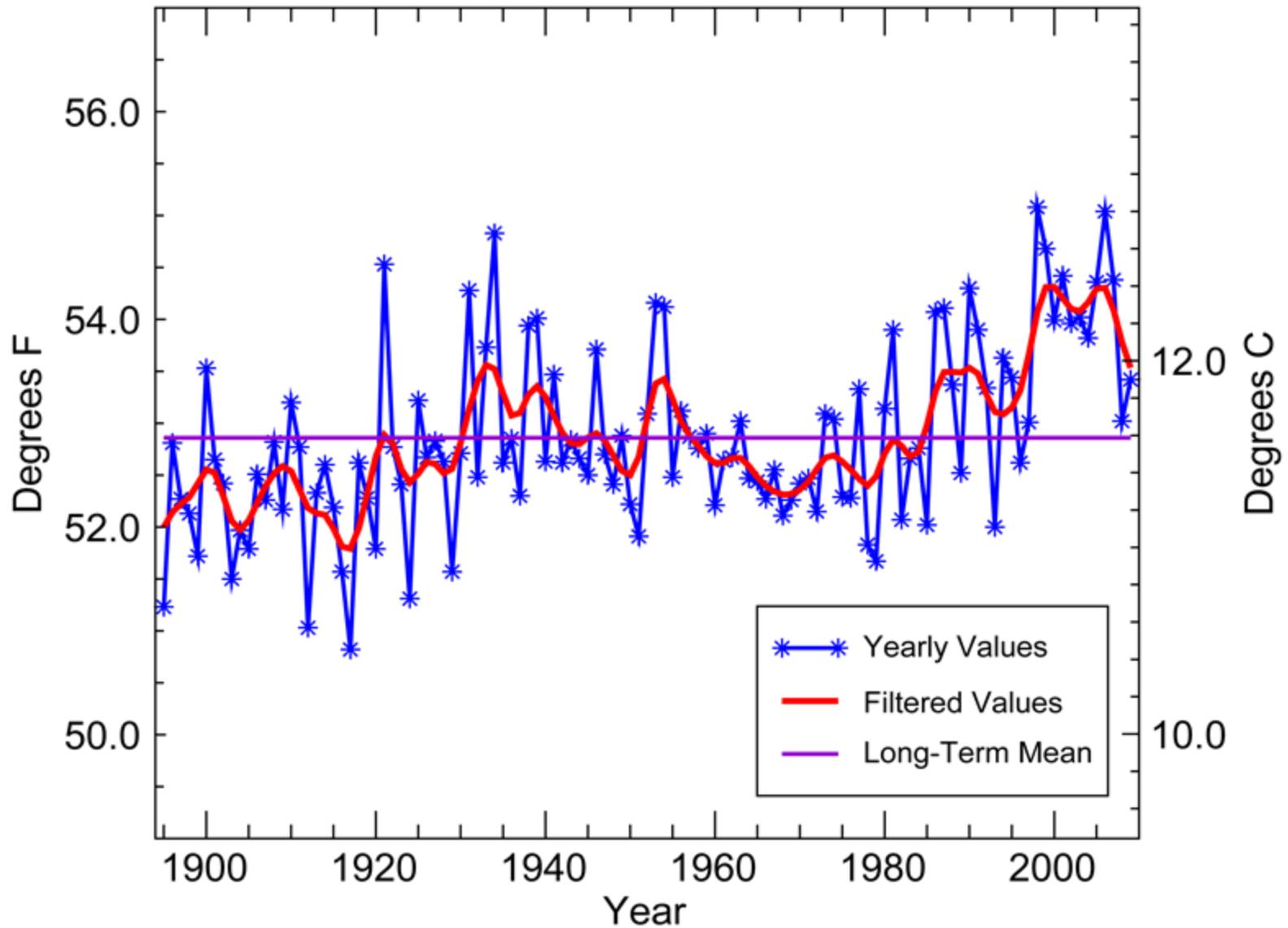
- Expenses on the organic farms were significantly lower than on the conventional - the latter spent 95% more on fertilizers and pesticides. Overall production costs on the organic farms were 26% lower.
- Thus, more farmers are adopting sustainable agricultural practices which, in turn, is helping to reduce the severity of the “Dead Zone”
- However, the impact of this disaster will occur for decades.

Sustainable Agriculture

Sustainable agricultural practices include:

- Crop rotations that mitigate weed, disease, and insect problems;
- Integrated pest management (IPM), which reduces the need for pesticides by crop rotations;
- Management systems to improve plant health and crops' abilities to resist pests and disease;
- Soil-conserving tillage;
- Water conservation and water-harvesting practices; and,
- Planting of leguminous crops and use of organic fertiliser or compost to improve soil fertility.

National (Contiguous U.S.) Temperature 1895 - 2009

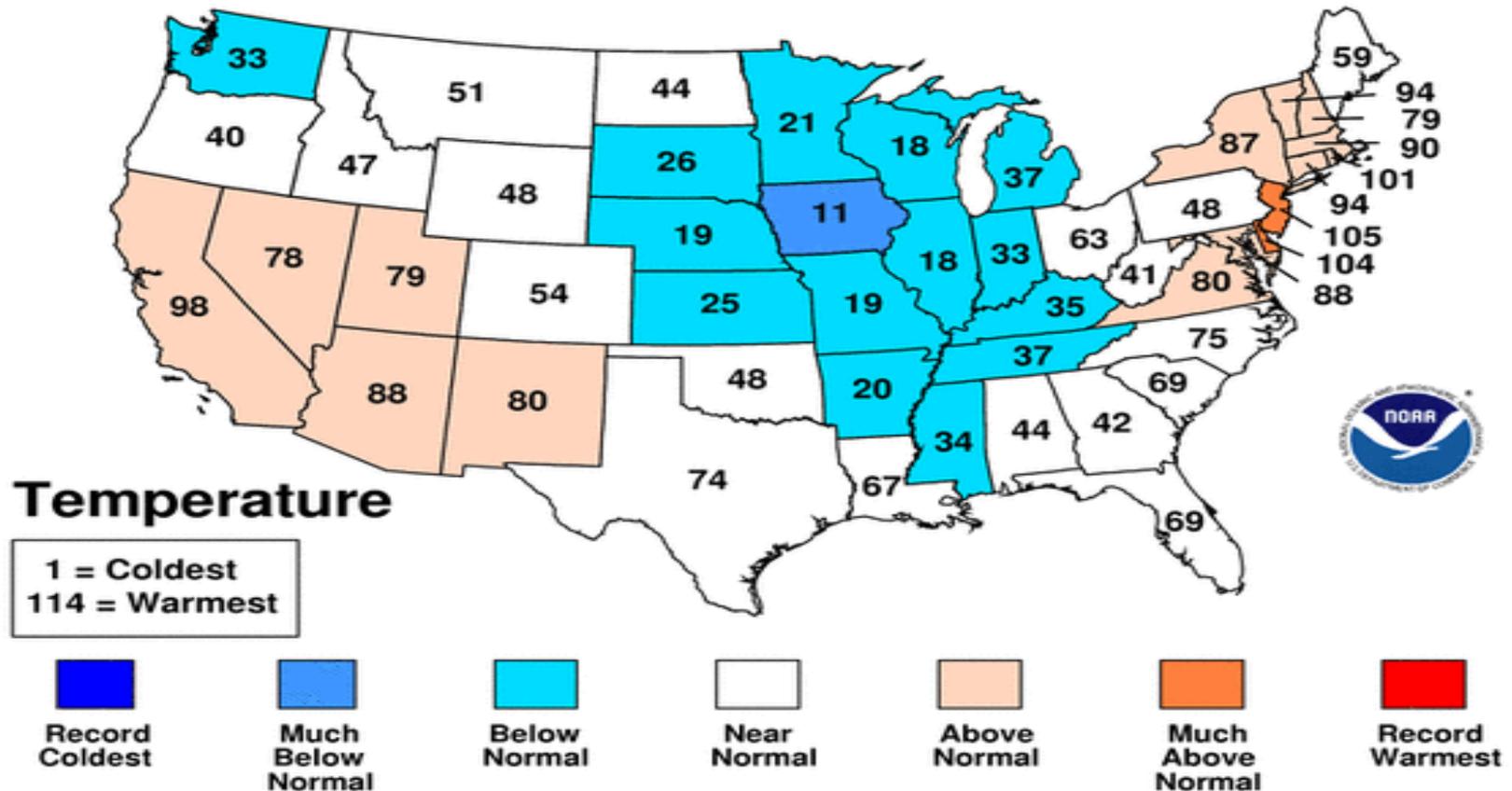


2008 Statewide Temperature Rankings

(based on 114 years of record)

January-December 2008 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA

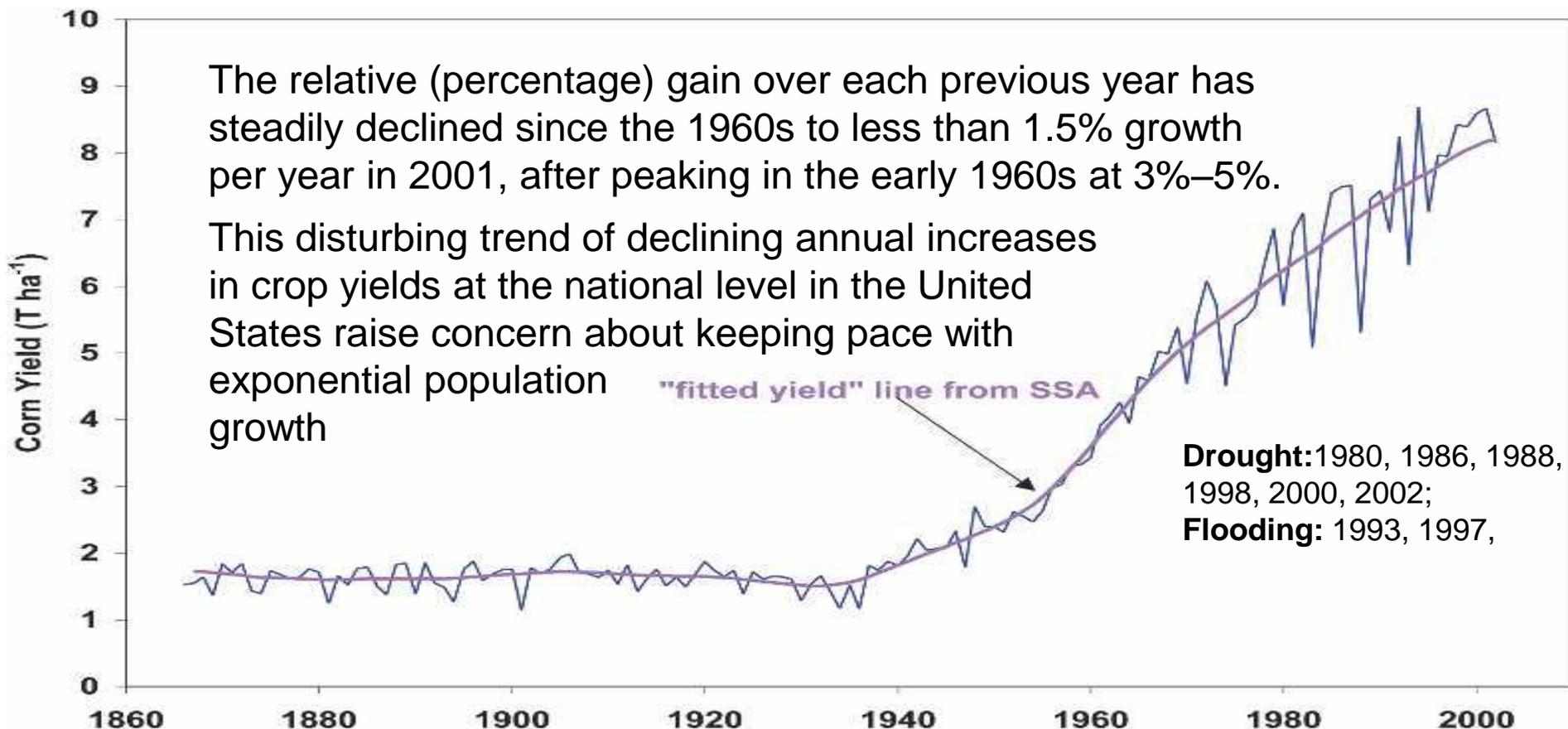


Climate Extremes Indicator (CEI)

- CEI indicator summarizes trends in temperature, precipitation, drought and tropical system data on an annual basis. The tropical system activity is based on the wind velocity of land-falling tropical storm and hurricanes.
- CEI calculations begin in 1910 for all periods and are updated within a few weeks after the end of a particular season and include final quality controlled data as well as near-real-time data.
- All graphs are plotted as bar graphs.

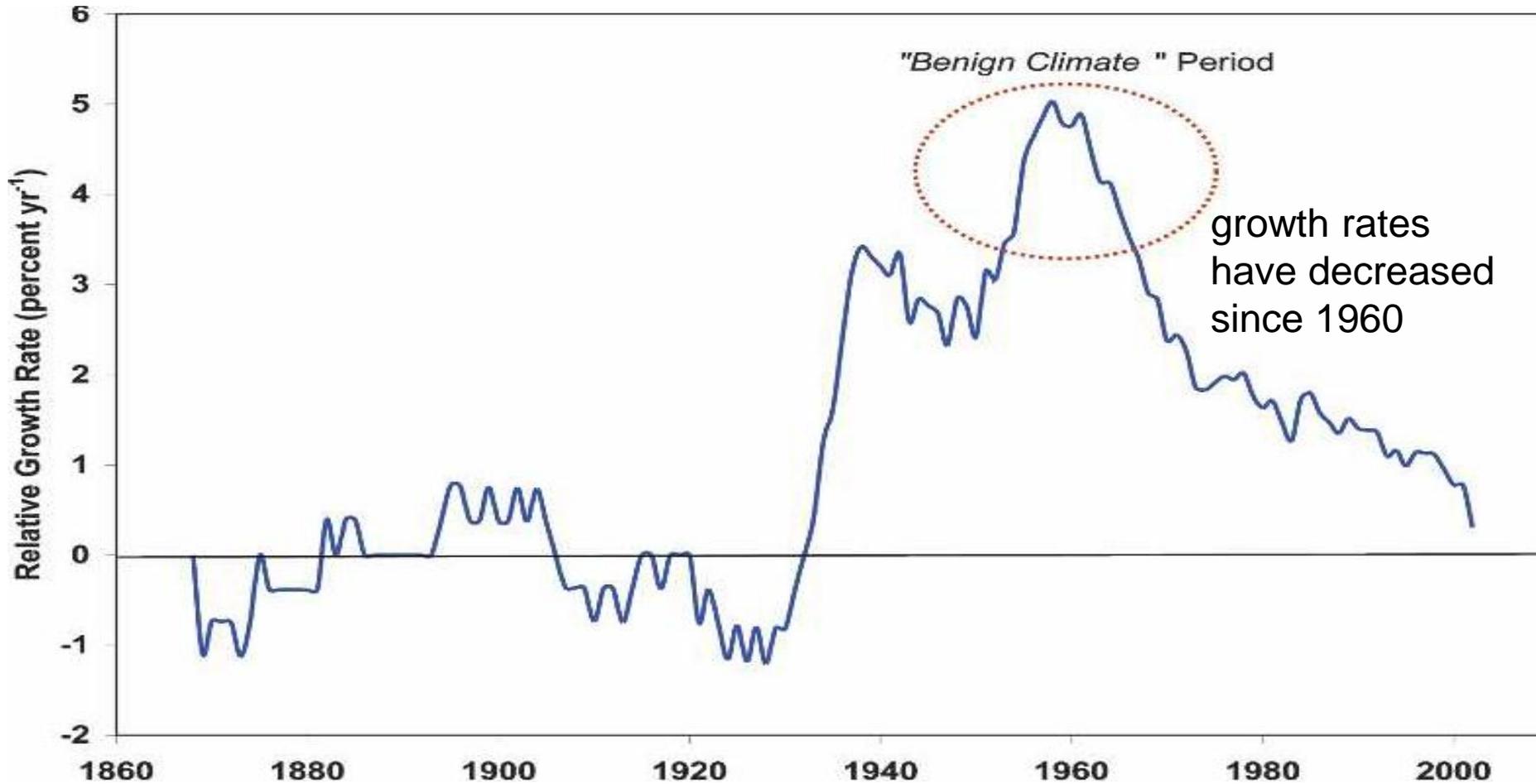
U.S. National Corn Yield

1865- 2002



The U.S. national corn yield average data from the USDA (blue line) and "fitted yield" line (pink line) using SSA.

Annual Corn Yield Growth Rate



Annual corn yield growth rate (% yr⁻¹) calculated from the fitted yield line

USDA Climate Change Science Plan (2010-2015)

Overview

The U.S. Department of Agriculture (USDA) Climate Change Science Plan (the Science Plan) provides a guide for the Department and its stakeholders of current and potential investments in climate change science activities.

USDA Science Plan

USDA has identified four priority elements concerning climate change.

1. Effects
2. Adaptation
3. Mitigation
4. Decision-Support

The USDA has identified a set of enabling activities that are common themes across each of the four elements: assessments; data and observations; analysis and modeling; and communication, outreach and education.

USDA Science Plan

Element 1: Effects

Examples of Departmental priorities include:

- Develop and coordinate programs to monitor climate change impacts and help improve model development;
- Research to quantify the effects of climate change on ecosystems, and impacts on agricultural production;
- Develop models and data systems to help project the impact of climate change on future agricultural and natural ecosystems.

USDA Science Plan

Element 2: Adaptation

Examples of Departmental priorities include:

- Facilitate adaptation management, and forecast potential future risks;
- Develop Best Management Practices for agriculture and natural ecosystems that provide resilience and productivity given the challenges associated with drought, heat stress, moisture stress, and changes in disease and pest prevalence;
- Disseminate materials and guidance to producers (farmers and ranchers) and managers regarding appropriate adaptive options to help optimize their operations.

USDA Science Plan

Element 3: Mitigation

Examples of Departmental priorities include:

- Improve infrastructure for operation and maintenance of national observing and monitoring systems (GHG, climate and agricultural production);
- Develop strategies and technologies for mitigating GHG emissions and adapting agriculture to changing climate;
- Determine where and how production systems could be modified to meet both food security and climate change mitigation goals.

USDA Science Plan

Element 4: Decision Support

Examples of Departmental priorities include:

- Increase public awareness of climate change science and solutions for policy and behavior change;
- Facilitate the use of decision-support models and tools developed to assess adaptation and mitigation strategies with user-friendly interfaces;
- Develop innovative partnerships between federal, states, academic, extension services, non-governmental, and local community organizations to address climate change issues in the agricultural industry;
- Create USDA assessment reports which address ecosystem responses to a range of changing climate patterns and atmospheric composition.



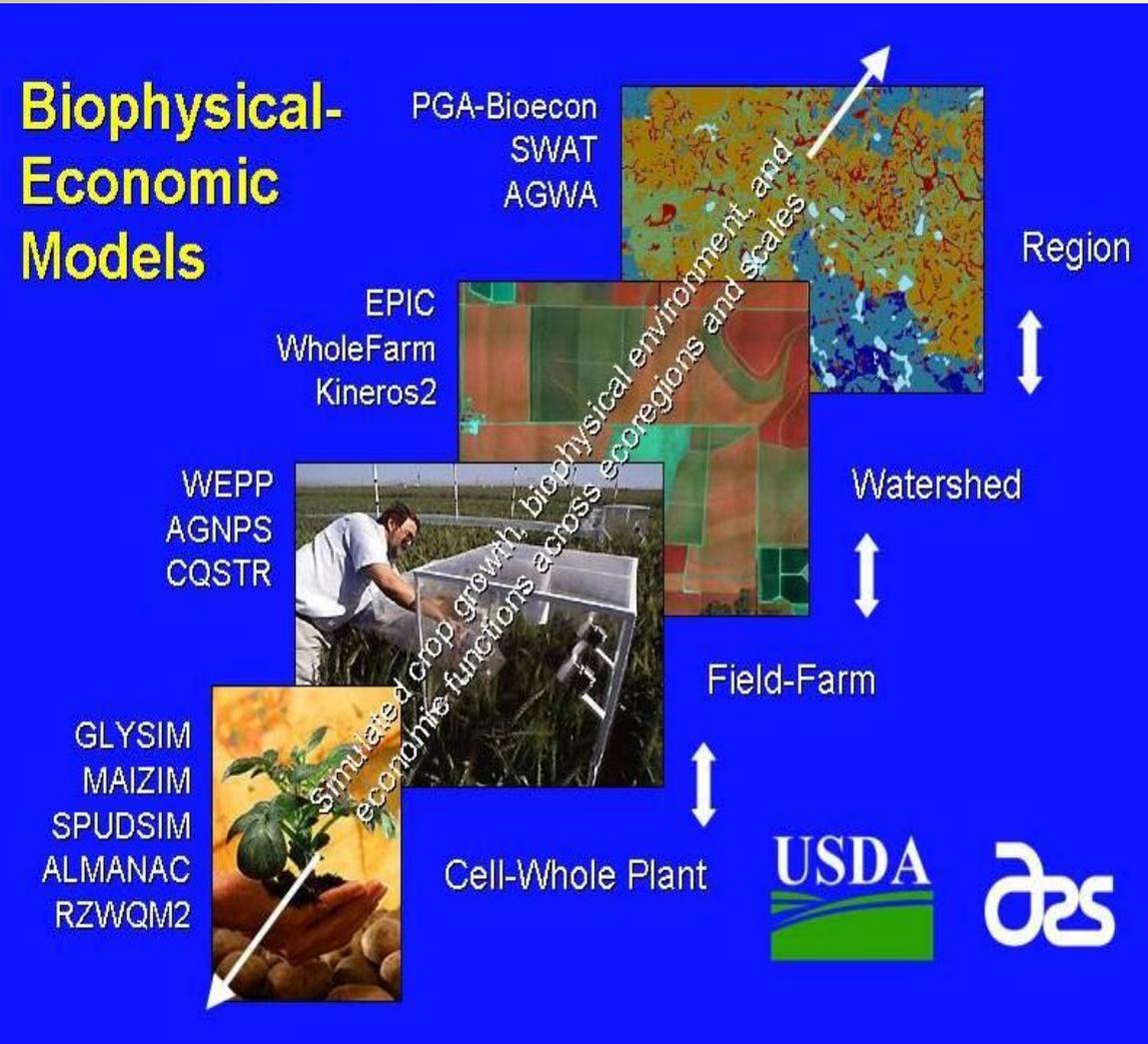
Thank You

ARS Research Infrastructure



- **Pre-existing research sites**
 - Watersheds, ranges, and (FS) experimental forests
 - Cropping systems sites
 - GRACENet CO₂ flux sites (Greenhouse gas Reduction through Agricultural Carbon Enhancement Network)
 - REAP sites (Renewable Energy Assessment Project)
- **Temporal and spatial coverage**
 - Long-term (81 sites > 20 years in ARS and FS)
 - Range of physiographic and ecological contexts
- **Reference material on web**
 - Moran, et al. 2008.

ARS Modeling



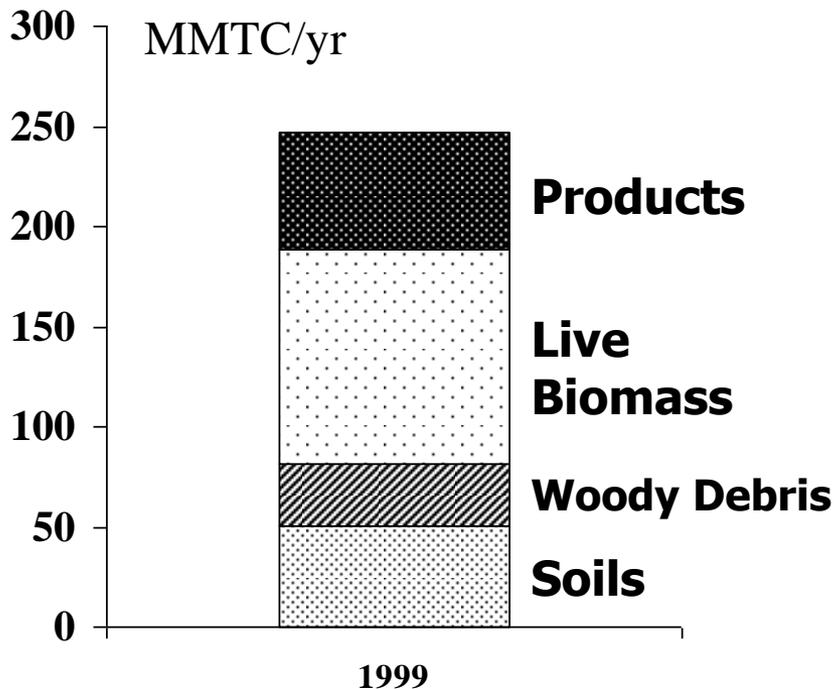
- **Models and model builders**
 - See USDA (ARS, ERS, and FS) models
 - See ARS Research Infrastructure & Models
- **Modelers**
 - One or more at most long-term sites
 - Knowledgeable about local context
- **Research using models**
 - Substantial published research

The USDA Forest Service

- **Largest forest land manager in the U.S.**
 - 147 million acres (20% of all forest land)
 - Additional 41 million acres of rangeland
- **Three main branches:**
 - National Forest System
 - State and Private Forestry
 - Research

Carbon Sequestration by US Forests

All US Forests



- **U.S. forests sequester carbon at a rate of 250 MMTC/yr -- 15% of U.S. emissions**

- **At \$5/ton, annual value of sequestration is more than \$1 billion**

- **It is technically feasible to increase the rate of carbon sequestration in forests by 150 MMTC/yr:**

- **Afforestation**

- **Improved management**

- **Efficient wood production**

- **Bio-products and energy**

- **Agroforestry**

USDA Science Plan Vision

To expand economic opportunity through innovation;

To help rural America thrive;

To promote sustainable agriculture production that nourishes Americans while also helps to feed others around the world; and,

To preserve and conserve our Nation's natural resources through restored forests, improved watersheds, and healthy private lands.