# Challenges and Opportunities
in
# Water Availability
and
# Watershed Management Research
in the
# Agricultural Research Service

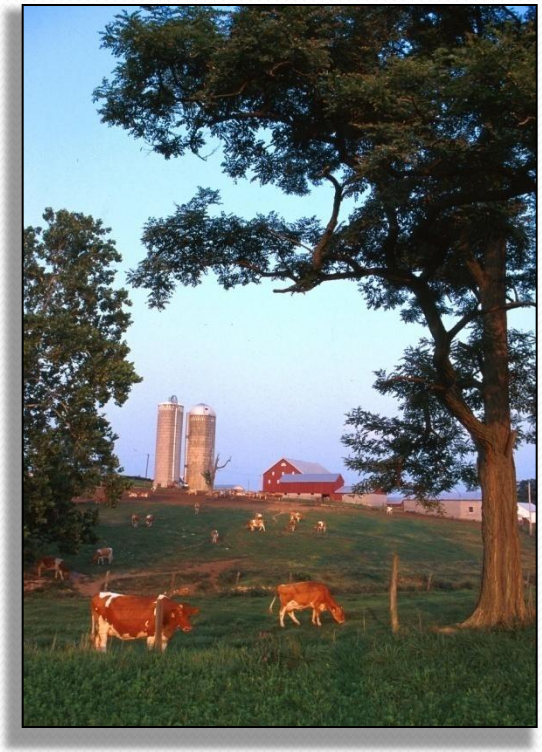
National Program 211 Workshop
Chicago, Illinois
September 8, 2010

***Steven Shafer***
***Deputy Administrator***
***Natural Resources & Sustainable Agricultural Systems***

USDA

ARS

# American Agriculture's Accomplishments



- 16% of the $9 trillion gross domestic product.
- 8% of U.S. exports.
- 17% of employment.
- < 2% U.S. workforce on farms.
- 100% of the citizens are users.

# Recent Trends

- 1930 to 2002: Agricultural workforce decreased from 22% to 2%
- Farmers working off-farm: increased from 30% to 93%
- Farming dependent non-metro counties decreased (became a minority)

# Research is an important part of USDA's mission

- "Practical and scientific experiments" since 1862.
- By World War II, USDA received about 40% of all Federal research funds.
- Agricultural Research Administration created during World War II.
- Agricultural Research Service created in 1953.

# Benefits of Agricultural Research

- Increased productivity
- Lower food prices
- Increased trade
- Improved quality of life

# Research has also helped producers address:

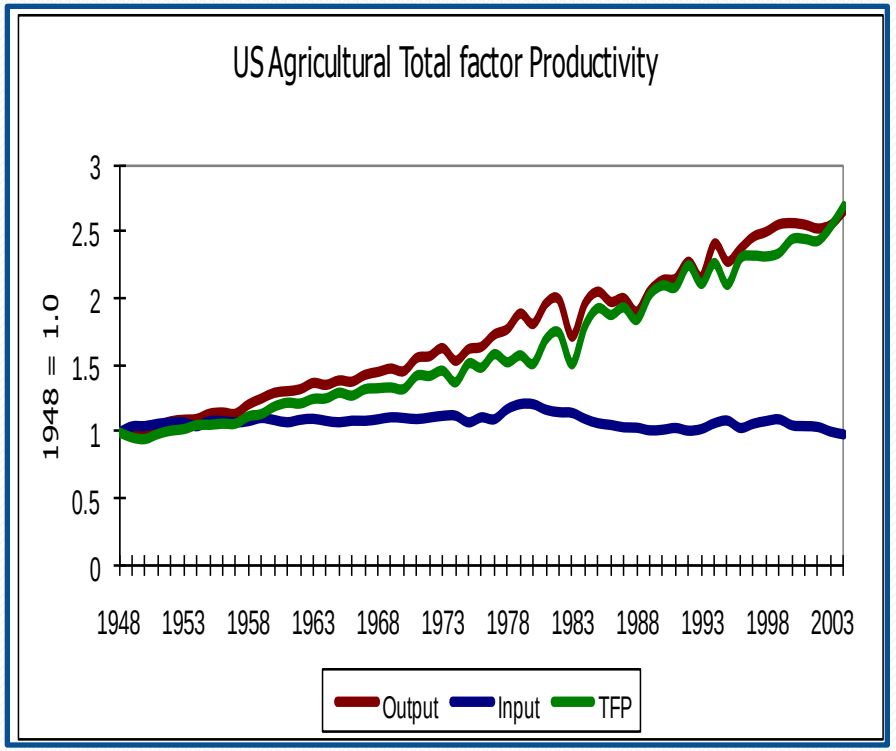
- Natural resource concerns.
- Changing market conditions.
- New technology introductions.
- Solving major problems.

# Trends in US Agricultural Productivity

## Since WWII in the U.S. ….

- Agricultural input growth was essentially flat
- All growth in output driven by productivity
- Productivity growth average ~2% per year

*Agriculture is a science-driven sector*




**Source: www.ers.usda.gov/Data/AgProductivity/**

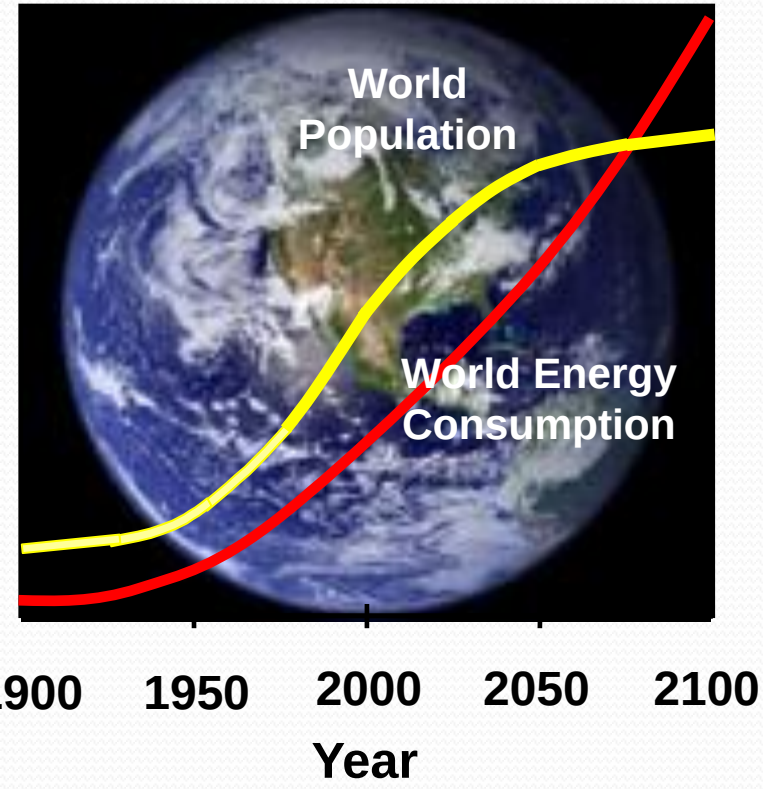
## Success of Agricultural Research

- Feeds a population in excess of 6 billion
- Uses only 0.2 ha (0.5 ac) of land per person

## Agricultural Concerns

- Intensive agriculture impacts the resource base.
- Reduces capacity and sustainability.

# Challenges ahead




- Food, feed, fiber production.
- Bio-based energy production.
- Water availability, drought, and water quality.
- Air quality and regulations.
- Production in a changing climate, while addressing safety and security.

# Two ways to increase production

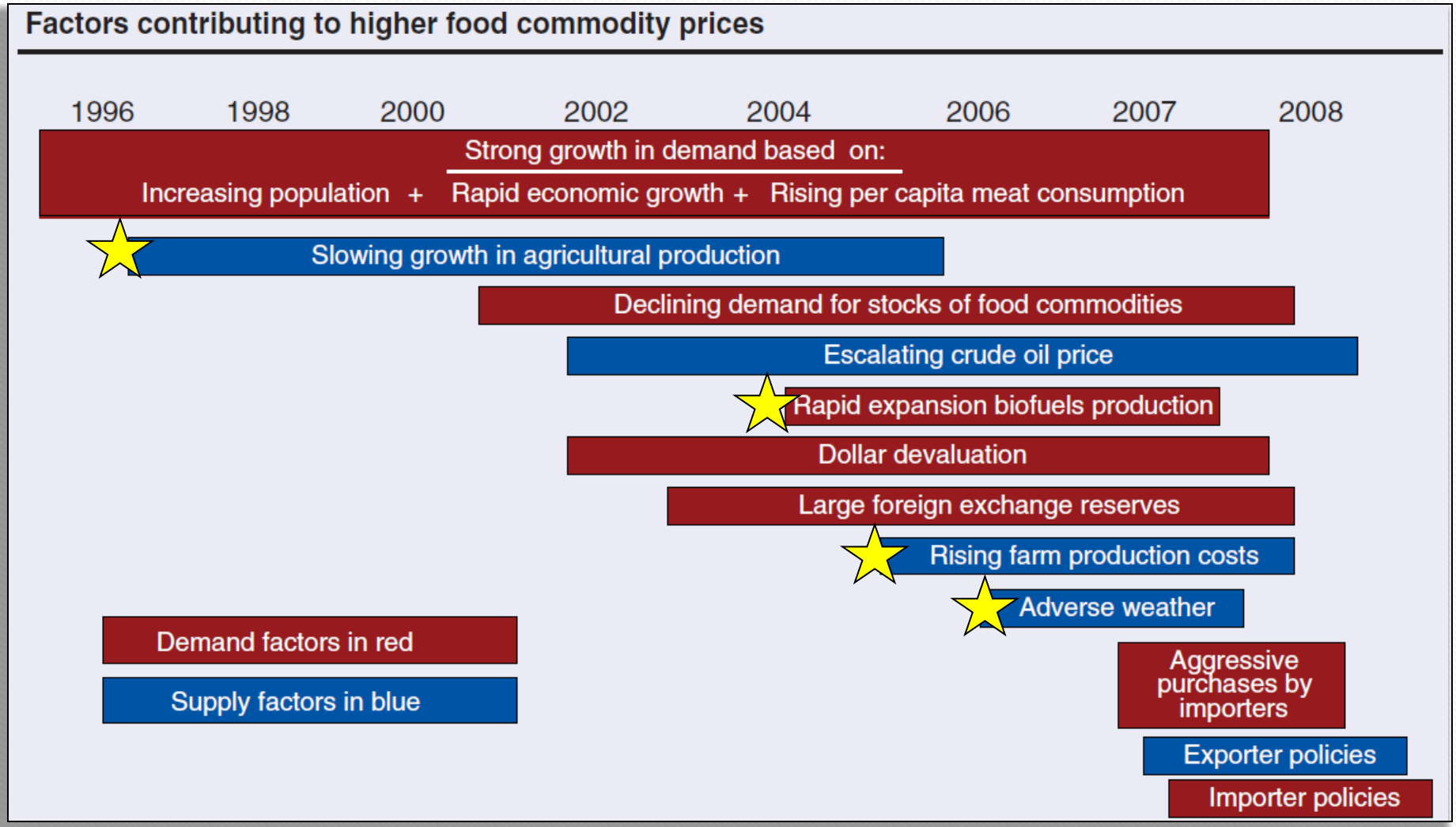
- Put more land under cultivation
- Produce more per unit land area ("ecological intensification")
  - ✓Mechanization
  - ✓Crop/livestock improvement
  - ✓Input use efficiency

# Global Trends 2025


**GLOBAL TRENDS 2025: THE NATIONAL INTELLIGENCE COUNCIL'S 2025 PROJECT**

http://www.dni.gov/nic/NIC_2025_project.html

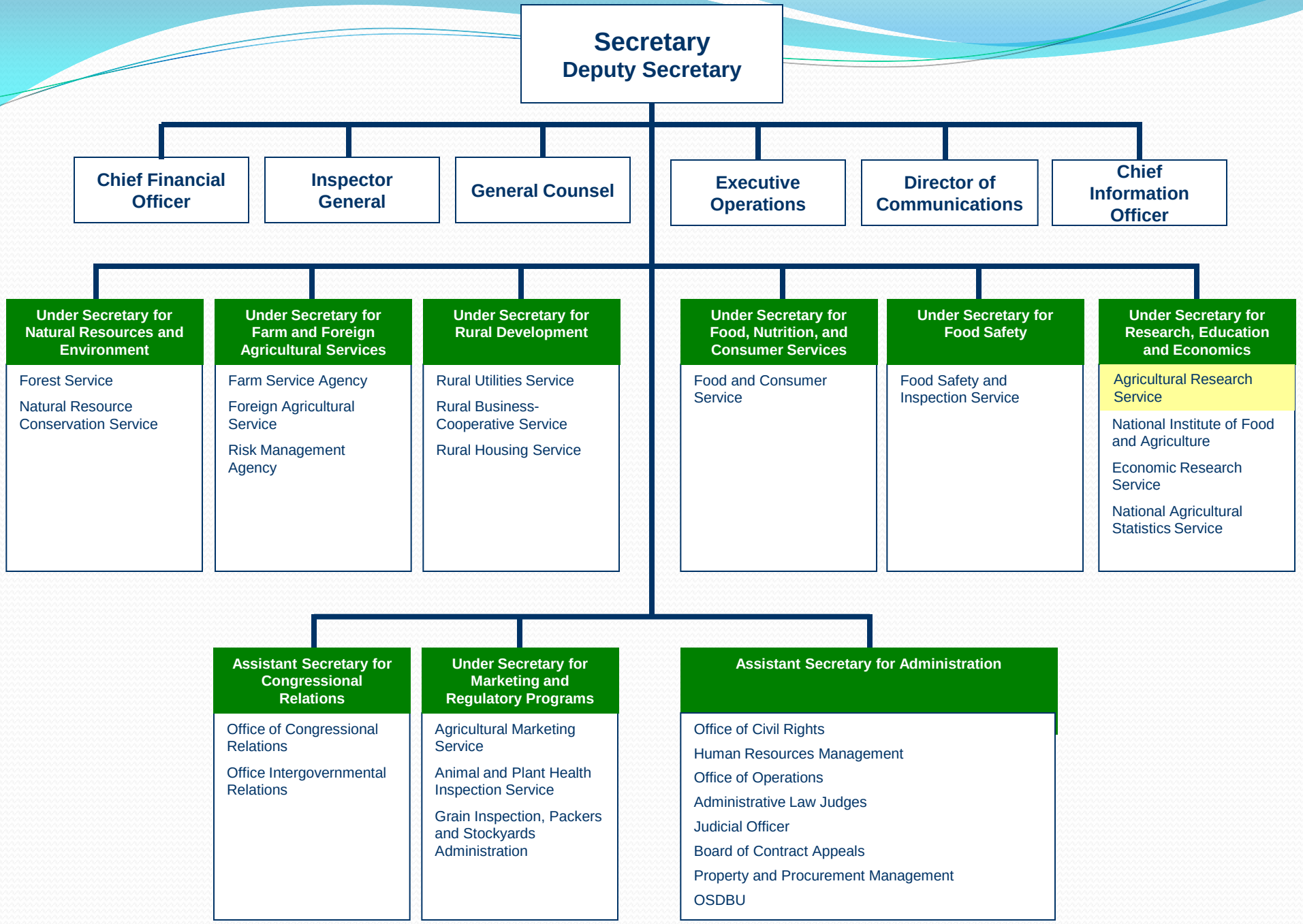
- **By 2025, droughts, food shortages and scarcity of fresh water will plague large swaths of the globe, from northern China to the Horn of Africa.**
- **For poorer countries, climate change "could be the straw that breaks the camel's back.“**
- **Floods and droughts will trigger mass migrations and political upheaval in many parts of the developing world.**
- **Energy security will also become a major issue as India, China and other countries join the United States in seeking oil, gas and other sources for electricity.**


Factors contributing to higher food commodity prices
1996
1998
2000
2002
2004
2006
2007
2008
Strong growth in demand based on:
Increasing population +
Rapid economic growth +
Rising per capita meat consumption
Slowing growth in agricultural production
Declining demand for stocks of food commodities
Escalating crude oil price
Rapid expansion biofuels production
Dollar devaluation
Large foreign exchange reserves
Rising farm production costs
Adverse weather
Demand factors in red
Supply factors in blue
Aggressive purchases by importers
Exporter policies
Importer policies

# USDA Strategic Goals

- Assist rural communities to create prosperity so they are self-sustaining, repopulating, and economically thriving.
- Ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources.
- Help America promote sustainable agricultural production and biotechnology exports as America works to increase food security.
- Ensure that all of America's children have access to safe, nutritious, and balanced meals.

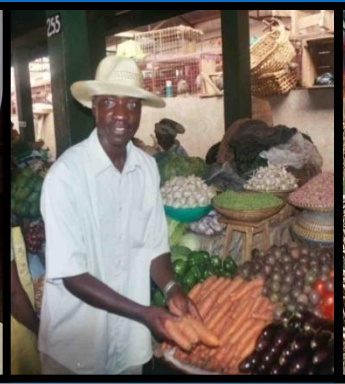




Secretary
Deputy Secretary
Chief Financial Officer
Inspector General
General Counsel
Executive Operations
Director of Communications
Chief Information Officer
Under Secretary for Natural Resources and Environment
Forest Service
Natural Resource Conservation Service
Under Secretary for Farm and Foreign Agricultural Services
Farm Service Agency
Foreign Agricultural Service
Risk Management Agency
Under Secretary for Rural Development
Rural Utilities Service
Rural Business-Cooperative Service
Rural Housing Service
Under Secretary for Food, Nutrition, and Consumer Services
Food and Consumer Service
Under Secretary for Food Safety
Food Safety and Inspection Service
Under Secretary for Research, Education and Economics
Agricultural Research Service
National Institute of Food and Agriculture
Economic Research Service
National Agricultural Statistics Service
Assistant Secretary for Congressional Relations
Office of Congressional Relations
Office Intergovernmental Relations
Under Secretary for Marketing and Regulatory Programs
Agricultural Marketing Service
Animal and Plant Health Inspection Service
Grain Inspection, Packers and Stockyards Administration
Assistant Secretary for Administration
Office of Civil Rights
Human Resources Management
Office of Operations
Administrative Law Judges
Judicial Officer
Board of Contract Appeals
Property and Procurement Management
OSDBU

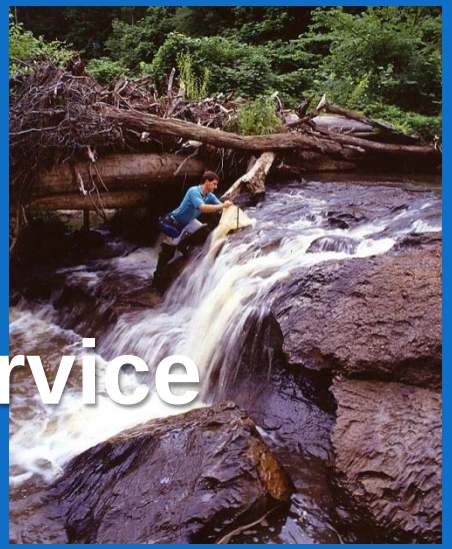
# ARS Strategic Goals

- Adaptation of agriculture to climate change.
- Improve the safety of America's food supply.
- Ensure that all of America's children have access to safe, nutritious, and balanced meals.
- Increase global food security through improved systems for sustainable agricultural productivity.
- Contribute to US bioenergy needs through development of improved feed stocks, feed stock production systems, and improved conversion technologies.



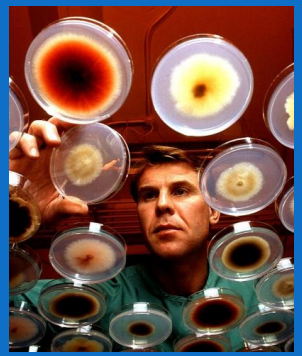




# Overview of the Agricultural Research Service

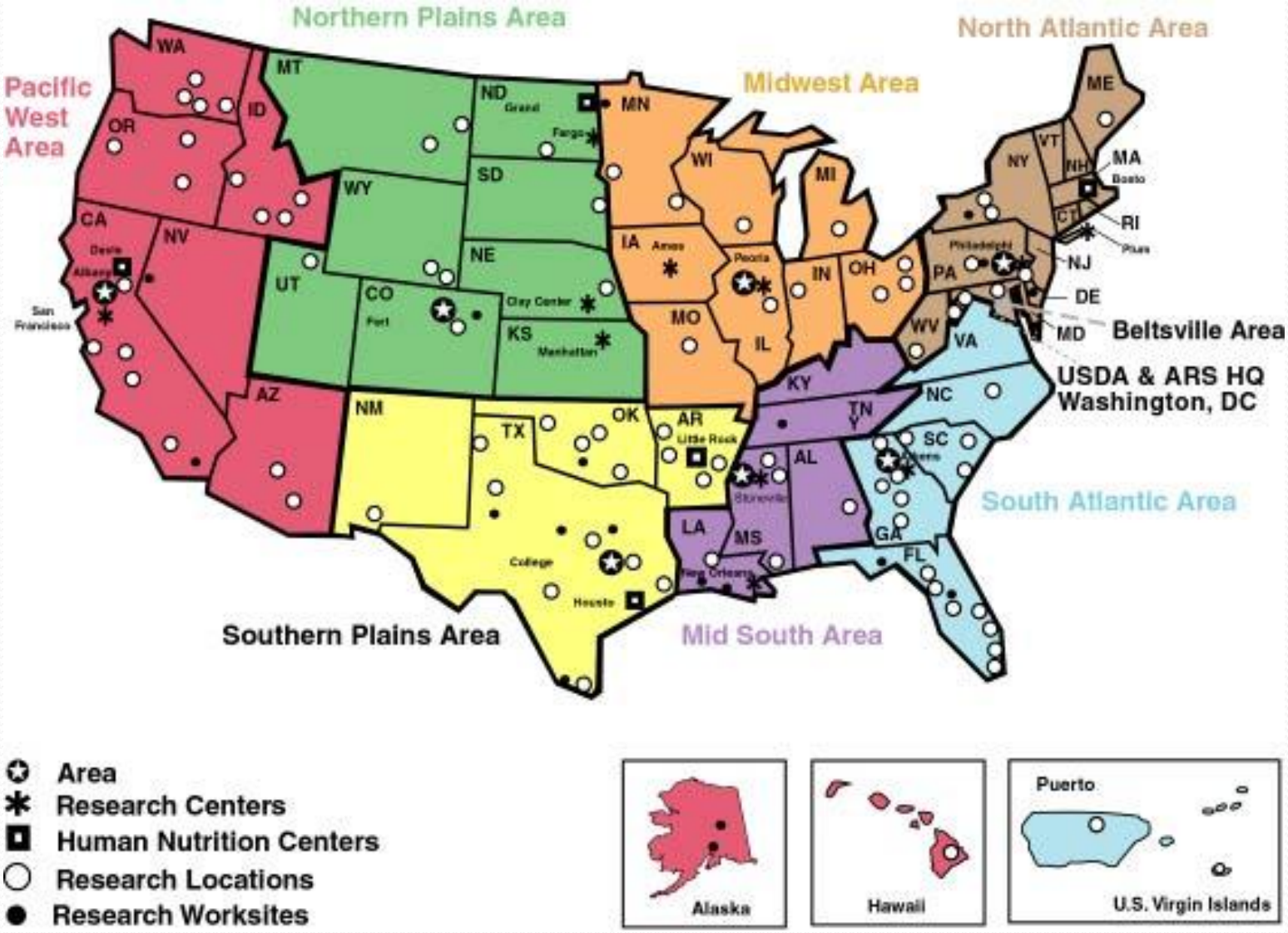


- In-house research arm of USDA
- Farm-to-table, molecules-to-watersheds research scope
- 21 National programs
- ~1,000 research projects
- Partnerships with universities and industry

- 8,300+ employees
- ~2,500 scientists and postdocs
- 100+ locations
- $1.2 billion annual budget
- Additional funds in competitive grants, CRADAs, other research agreements



# ARS Locations

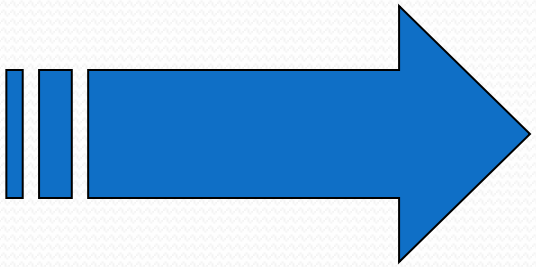


# Research Models

- Investigator Driven
  - ✓ Typical of Universities
  - ✓ Hired to work in research area
  - ✓ Relevance driven by the investigator
- Mission Driven
  - ✓ ARS
  - ✓ Hired to work in a mission area defined by the Agency, based on broad input
  - ✓ Relevance is driven by a complex process of congressional, stakeholder, and scientist input

# Providing a *scientific foundation* for decision making in agriculture

***"Our mission is to conduct research to develop and transfer solutions to agricultural problems of high national priority and provide information access and dissemination to . . ."***



**Mission Driven Research**

Ensure high-quality, safe food and other products

Assess the nutritional needs of Americans

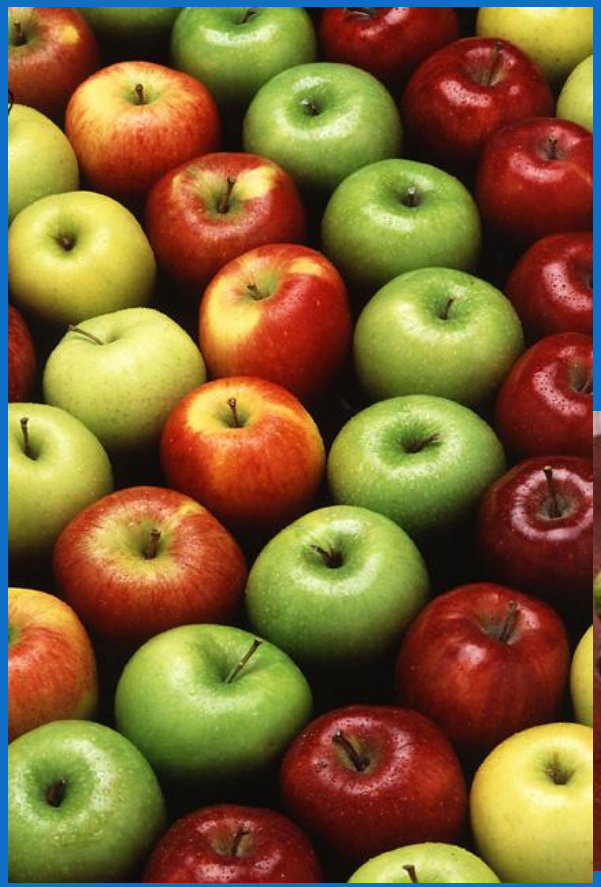
Sustain a competitive agricultural economy

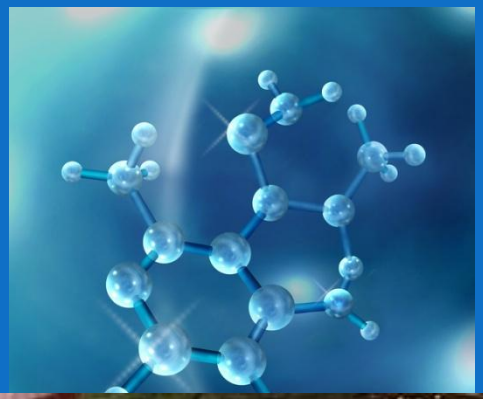
Enhance the natural resource base and the environment

Provide economic opportunities for rural citizens, communities, and society as a whole

# Comprehensive Research and Development Programs

- Apples to Zucchinis
- Molecules to Watersheds





# ARS National Programs

**Judy St. John**

**Associate Administrator**

## Natural Resources & Sustainable Agric. Sys.

**Steven Shafer**

- Water Availability and Watershed Management
- Global Change, Soil and Emissions
- Bioenergy and Bioproducts
- Agricultural Waste and Byproduct Utilization
- Pasture, Forage and Range Land Systems
- Agricultural System Competitiveness and Sustainability

## Crop Production & Protection

**(Acting)**

- Plant, Microbial & Insect Germplasm Conservation & Development
- Plant Biological & Molecular Processes
- Plant Diseases
- Crop Protection & Quarantine
- Crop Production
- Methyl Bromide Alternatives

## Animal Production & Protection

**Steven Kappes**

- Food Animal Production
- Animal Health
- Arthropod Pests of Animals and Humans
- Aquaculture

## Nutrition, Food Safety & Quality

**Molly Kretsch**

- Human Nutrition
- Food Safety
- New Uses, Quality & Marketability of Plant & Animal Products

# Benefits of National Programs

**Coordination**

**Communication**

**Efficient use of resources**

**Results**

# ARS Research in Natural Resources & Sustainable Agricultural Systems

- 184 Research Projects
- 72 Locations
- 540 Scientists

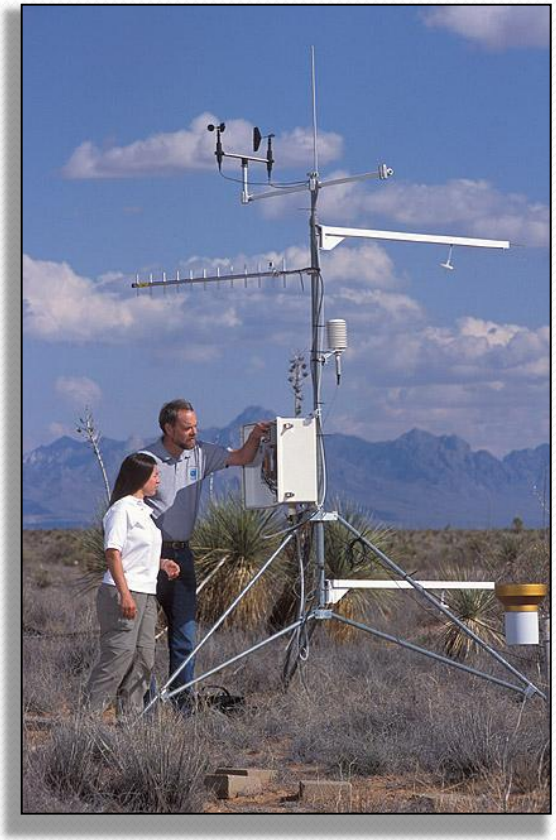
- Water Availability & Watershed Management
- Climate Change, Soils, and Emissions
- Bioenergy and Energy Alternatives
- Agricultural and Industrial Byproducts
- Pasture, Forage, and Rangeland Systems
- Agricultural System Competitiveness and Sustainability

# Water Availability & Watershed Management

**Total Projects: 51**
**Total Locations: 33**
**Total Scientists: 153**

- Effectiveness of Conservation Practices
- Irrigation Water Management
- Drainage Water Management Systems
- Integrated Erosion and Sedimentation Technologies
- Watershed Management, Water Availability, and Ecosystem Restoration
- Water Quality Protection Systems

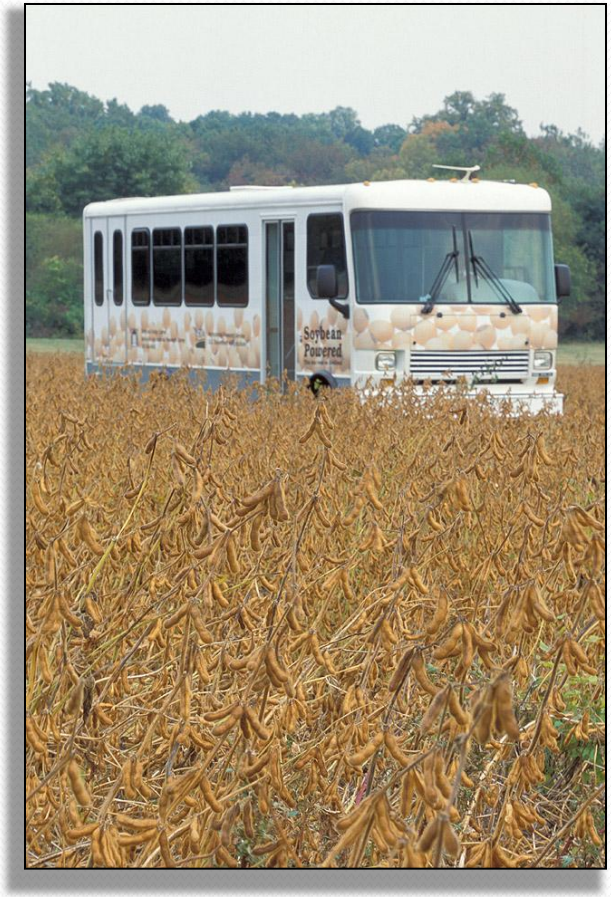
# Climate Change, Soils, and Emissions



**Total Projects: 42**
**Total Locations: 32**
**Total Scientists: 103**

- **Enable Improvements of Air Quality via Management and Mitigation of Emissions from Agricultural Operations**
- **Develop Knowledge and Technologies for Reducing Atmospheric Greenhouse Gas Concentrations Through Management of Agricultural Emissions and Carbon Sequestration**
- **Enable Agriculture to Adapt to Climate Change**
- **Maintain and Enhance Soil Resources**

# Bioenergy and Energy Alternatives




**Total Projects: 16**
**Total Locations: 7**
**Total Scientists: 48**

- **Feedstock Development (*Enable new varieties and hybrids of bioenergy feedstocks with optimal traits)***
- **Sustainable Feedstock Production Systems (*Enable new optimal practices and systems that maximize the sustainable yield of high-quality bioenergy feedstocks)***
- **Biorefining (*Enable new, commercially preferred biorefining technologies)***

# Agricultural and Industrial Byproducts


- Management, Enhancement, and Utilization of Manure
- Nutrients and Resources
- Manure Pathogens and Pharmaceutically Active Compounds (PACs)
- Atmospheric Emissions
- Developing Beneficial Uses of Agricultural, Industrial and Municipal Byproducts

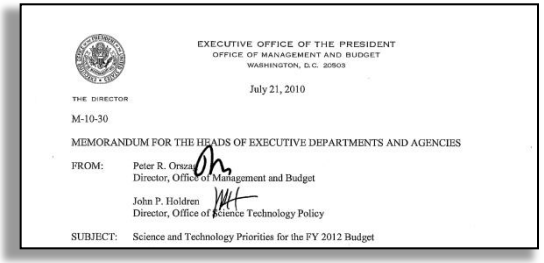
**Total Projects: 22**
**Total Locations: 17**
**Total Scientists: 58**

# Pasture, Forage, and Rangeland Systems

**Total Projects: 35**
**Total Locations: 25**
**Total Scientists: 110**

- **Rangeland Management Systems to Improve Economic Viability and Enhance the Environment**
- **Pasture Management Systems to Improve Economic Viability and Enhance the Environment**
- **Sustainable Harvested Forage Systems for Livestock,**
- **Bioenergy and Bioproducts**
- **Sustainable Turf Systems**

## Challenges and Areas to be Strengthened *(not complete here)*



EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

July 21, 2010

THE DIRECTOR

M-10-30

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: Peter R. Orszag
Director, Office of Management and Budget

John P. Holdren
Director, Office of Science Technology Policy

SUBJECT: Science and Technology Priorities for the FY 2012 Budget

- Promoting sustainable economic growth and job creation
  - Support research for a "bio-economy" ….biotechnology and biosystems to address critical needs in agriculture, energy, health, and the environment.
- Defeating the most dangerous diseases and achieving better health outcomes for all while reducing health care costs.
- Moving toward a clean energy future to reduce dependence on energy imports while curbing greenhouse gases.
  - R&D for clean energy technologies, esp. next-generation biofuels (and others)
- Understanding, adapting to, and mitigating the impacts of global climate change.
  - Support interagency investments in the USGCRP, an integrated and continuing National Climate Assessment, incl. science….
- Managing the competing demands on land, fresh water, and the oceans for the production of food, fiber, biofuels, and ecosystem services based on sustainability and biodiversity.
  - Support research on integrated ecosystem management approaches….[for] forecast models, assessments, and decision support tools.
- Developing the technologies to protect our troops, citizens, and national interests.
- Addressing these challenges will require strengthening our efforts in six cross-cutting areas:
  - Science, technology, engineering and mathematics education…..
  - Vitality and productivity of research universities, public and private laboratories, with sustained support for fundamental research.
  - Infrastructures for information and communication, transportation, and energy.
  - High-impact collaborations with researchers, private sector, universities, civil society, and international partners to achieve US foreign policy, global health, energy, climate change, and global development objectives.
  - Capabilities in space, incl. Earth observation, geopositioning, other.
  - Economic and policy environment that promotes and rewards research, entrepreneurship, and innovation.

# ARS Partners In Research

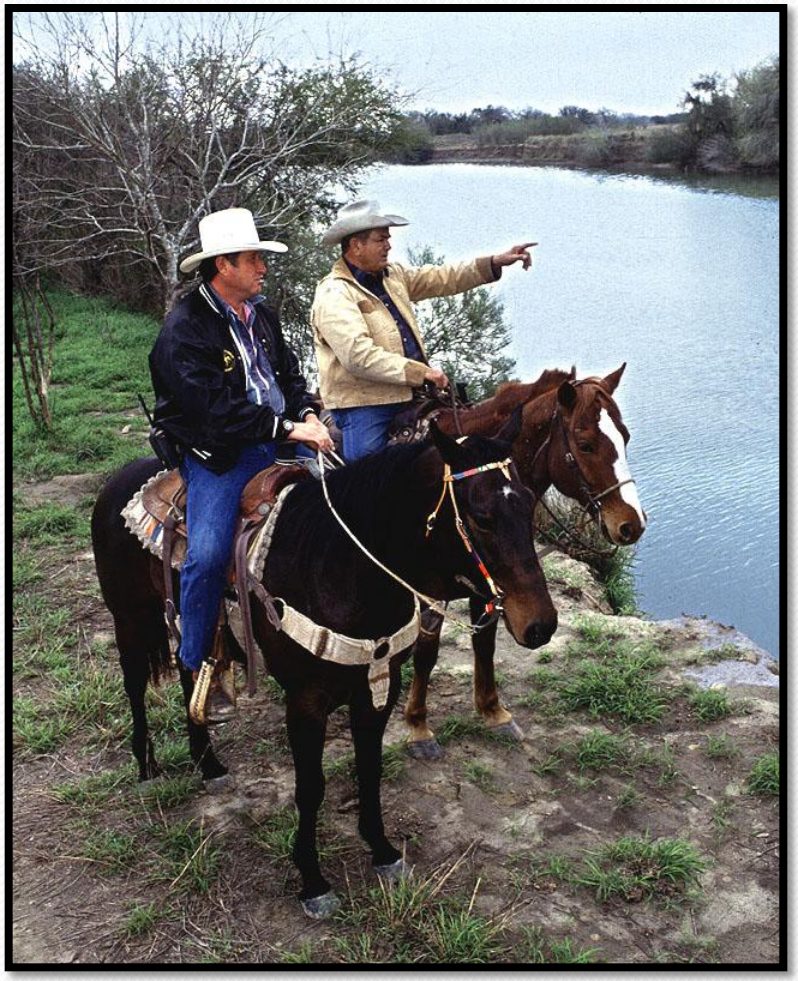
- USDA
- Other Government Agencies
- State Universities
- International Organizations
  - U.N. Food and Agriculture Organization
  - World Bank
  - Consultative Group of International Agricultural Research
  - Tropical Ag Research & Highe Ed Center
  - U.S./Israel BARD

# ARS Planning and Priority Setting

- **Stakeholder input**
- **Program planning cycle**

# ARS Customers & Stakeholders

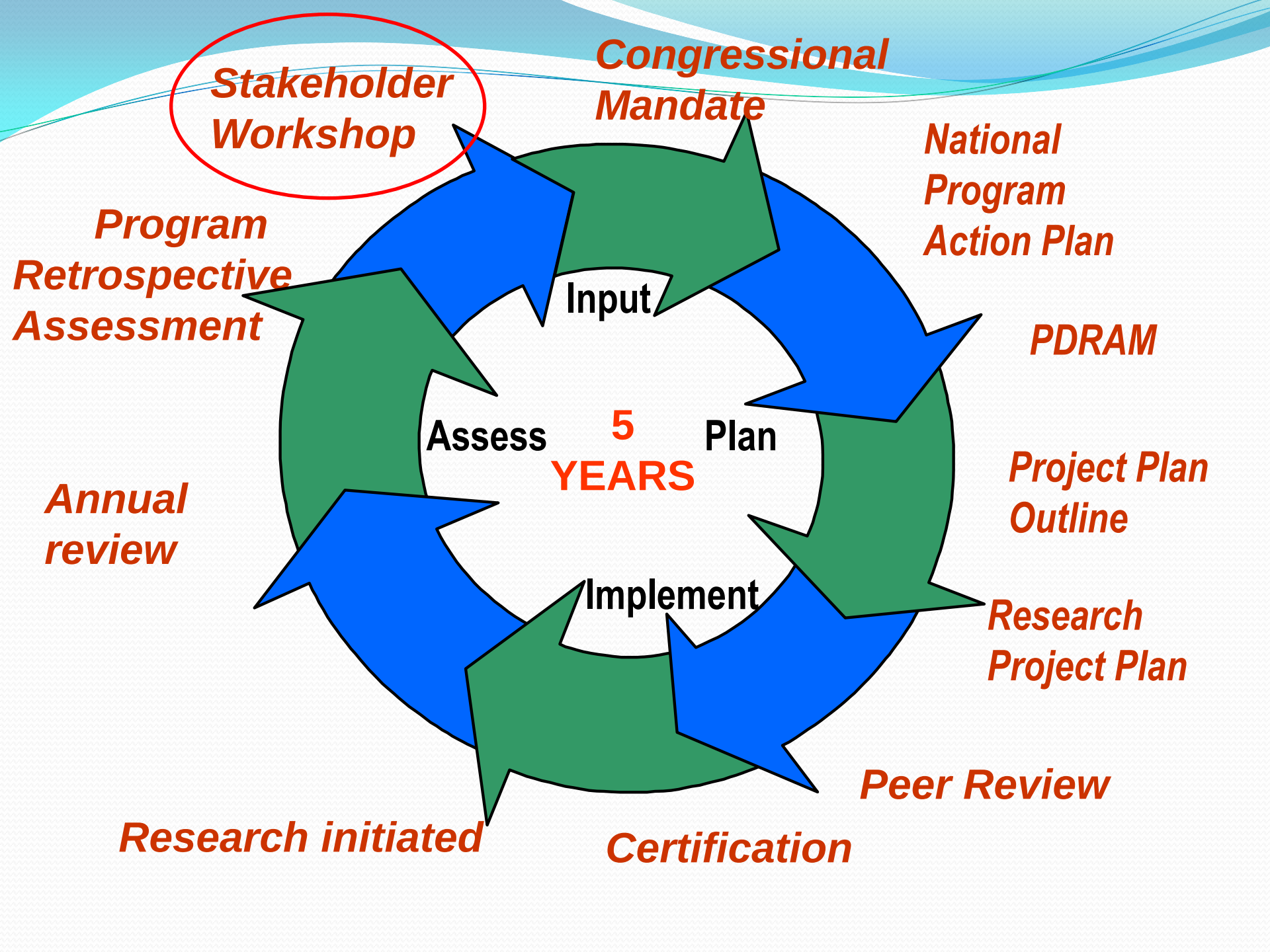
- Action and Regulatory Agencies
- Producers–Farmers and Ranchers
- Industry
- Non-governmental Organizations (NGOs)
- State and Local Governments
- Consumers




President, Secretary & Congress
Customers
ARS Priorities
Other Agencies
Scientific Community

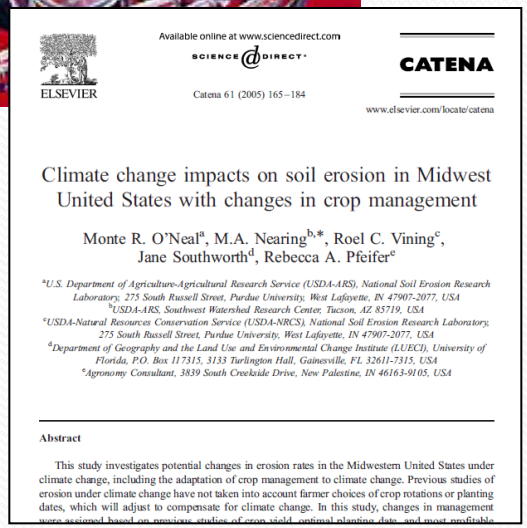
# ARS Scientific Peer Review Process

- Verify scientific merit.
- At least once every 5 years; majority of reviewers external scientists.


Stakeholder Workshop
Congressional Mandate
National Program Action Plan
PDRAM
Project Plan Outline
Research Project Plan
Peer Review
Certification
Research initiated
Annual review
Program Retrospective Assessment
Input
Plan
Implement
Assess
5 YEARS

# Information Dissemination and Technology Transfer


- Scientific Publications
- Office of Technology Transfer
- National Agricultural Library
- Information Staff



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Climate change impacts on soil erosion in Midwest United States with changes in crop management

Monte R. O'Neal[a], M.A. Nearing[b,*], Roel C. Vining[c], Jane Southworth[d], Rebecca A. Pfeifer[e]

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[b]USDA-ARS, Southwest Watershed Research Center, Tucson, AZ 85719, USA
[c]USDA-Natural Resources Conservation Service (USDA-NRCS), National Soil Erosion Research Laboratory, 275 South Russell Street, Purdue University, West Lafayette, IN 47907-2077, USA
[d]Department of Geography and the Land Use and Environmental Change Institute (LUECI), University of Florida, P.O. Box 117315, 3133 Turlington Hall, Gainesville, FL 32611-7315, USA
[e]Agronomy Consultant, 3839 South Creekside Drive, New Palestine, IN 46163-9105, USA

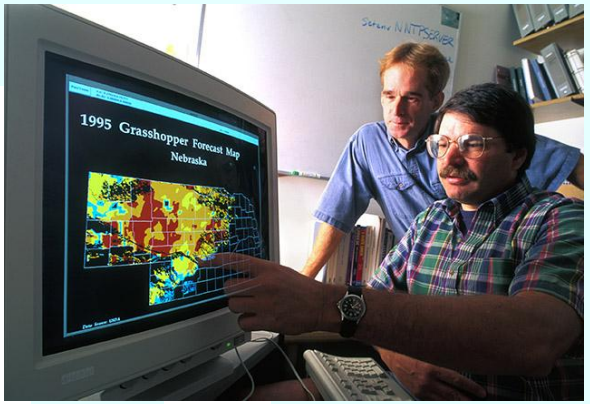
**Abstract**

This study investigates potential changes in erosion rates in the Midwestern United States under climate change, including the adaptation of crop management to climate change. Previous studies of erosion under climate change have not taken into account farmer choices of crop rotations or planting dates, which will adjust to compensate for climate change. In this study, changes in management were assigned based on previous studies of crop yield, optimal planting date, and most profitable

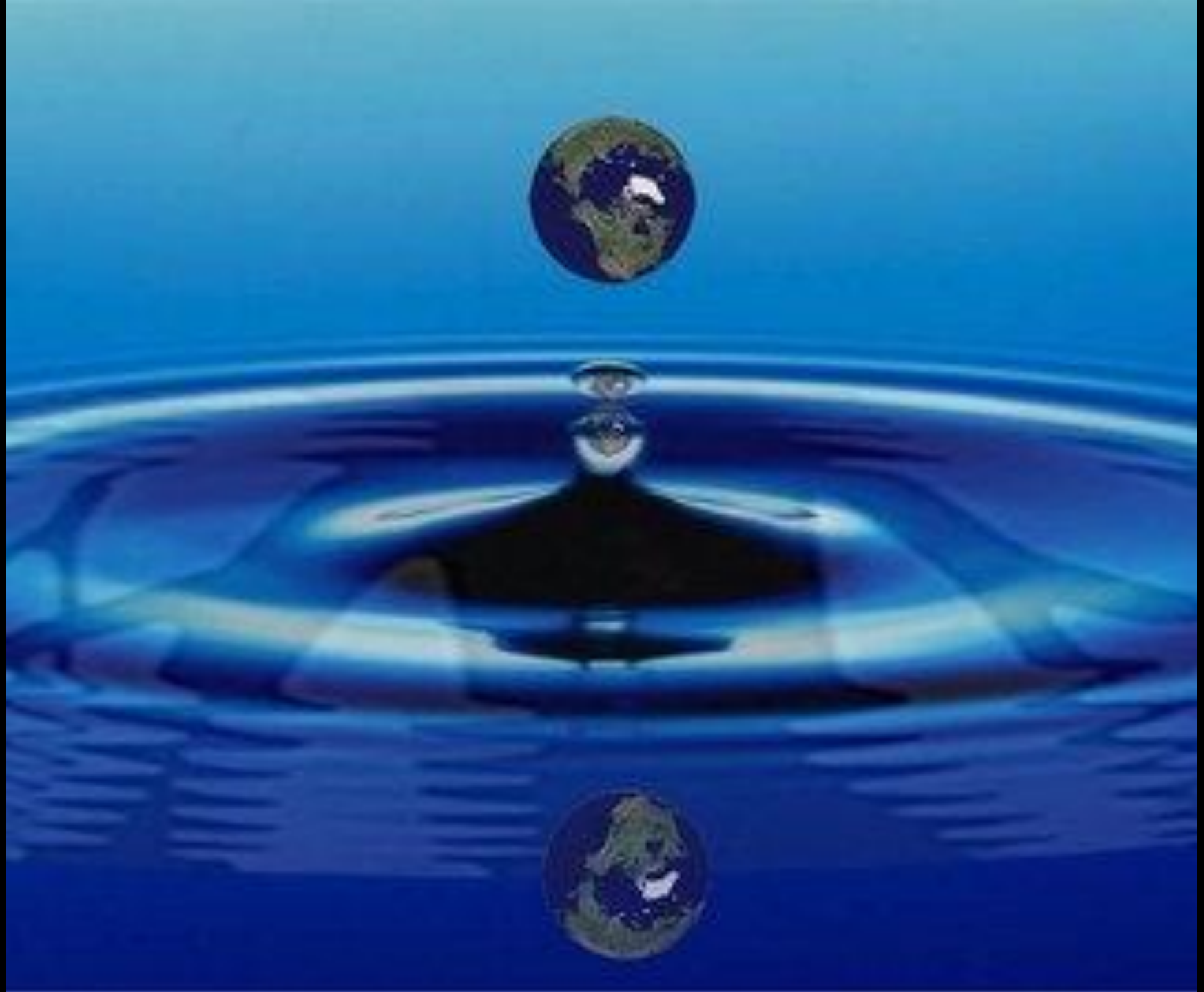
www.ars.usda.gov

**Research that *Explains***

**Research that *Predicts***




**Research that *Supports Decision Making***



# U.S. Water Use by Sectors

Livestock

Less than 1 percent

Domestic

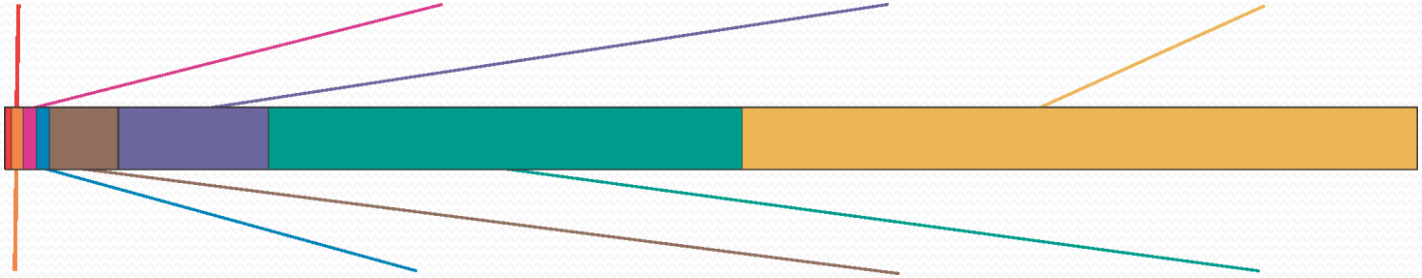
Less than 1 percent

Public Supply

11 percent

Thermoelectric power

48 percent



Less than 1 percent

Mining

Less than 1 percent

Aquaculture

5 percent

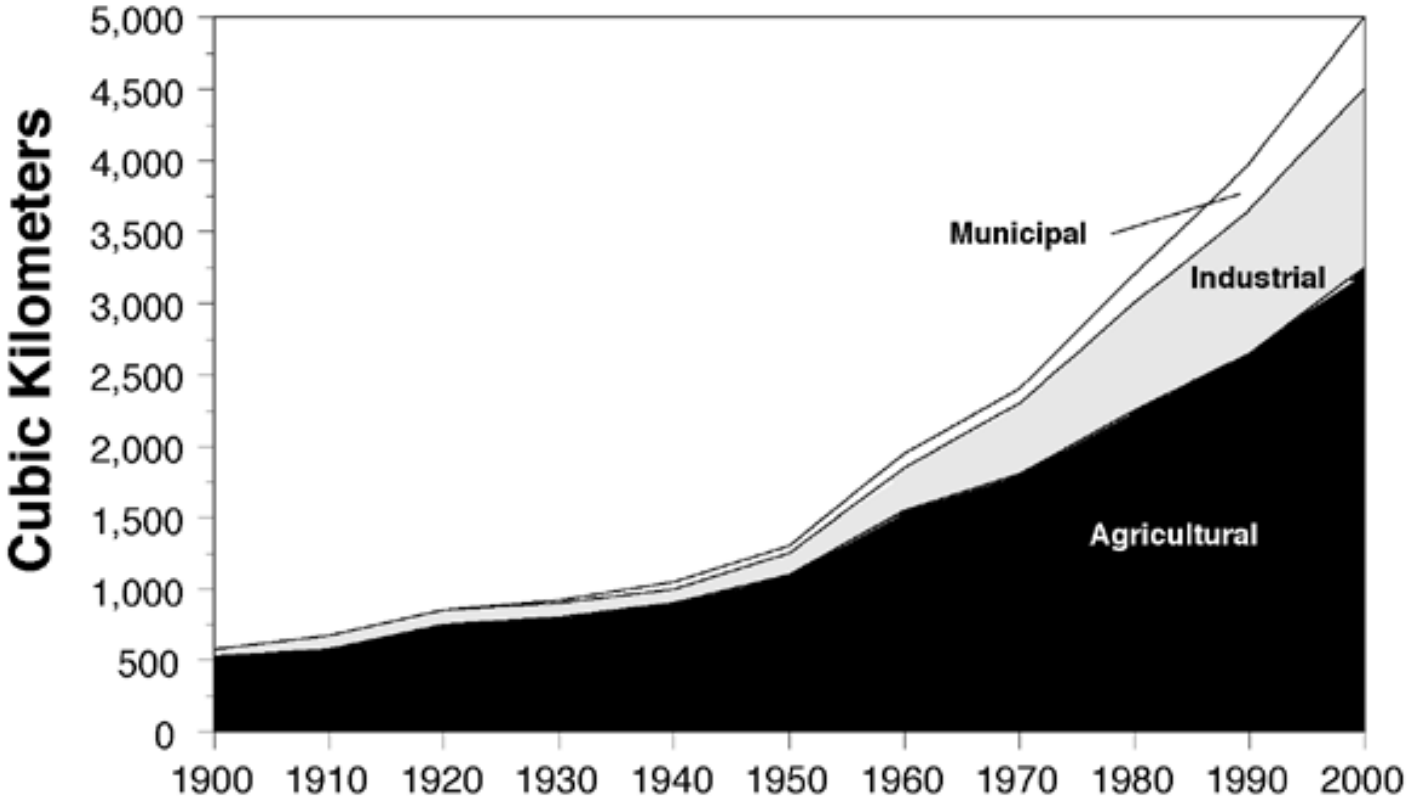
Industrial

34 percent

Irrigation

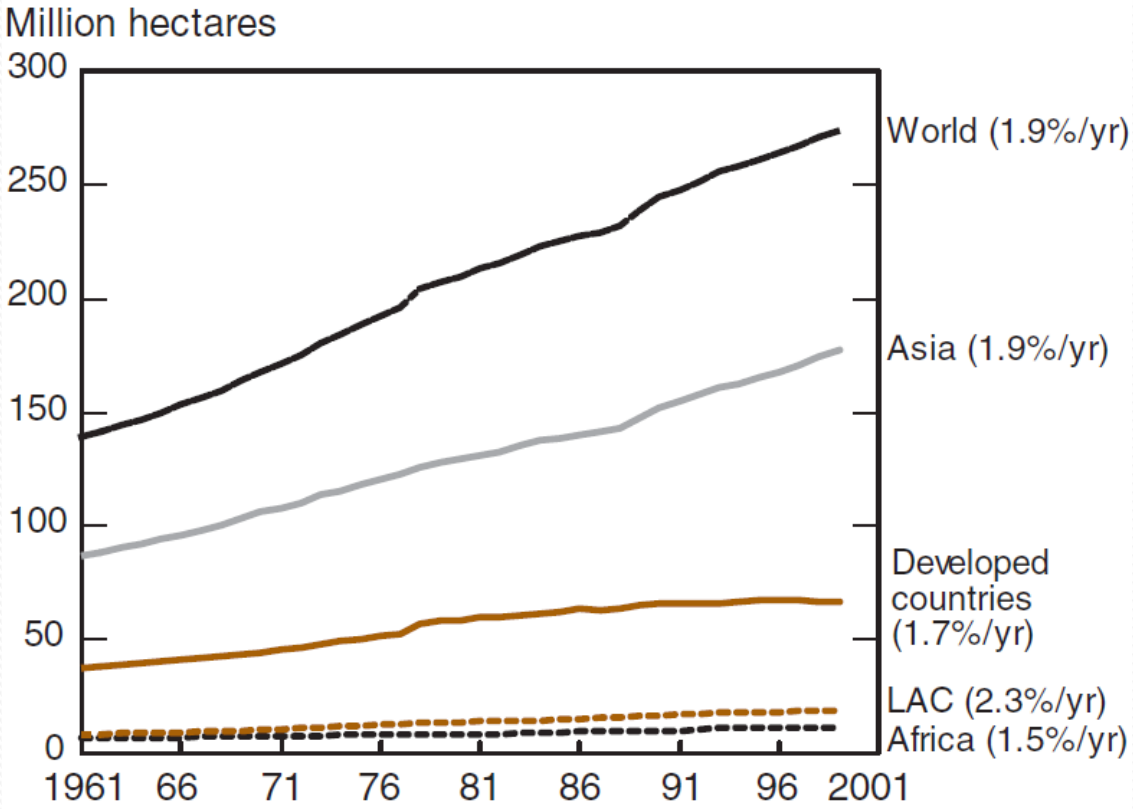
# Figure 4. Rising Water Use

## Global Annual Water Withdrawal by Sector, 1900–2000



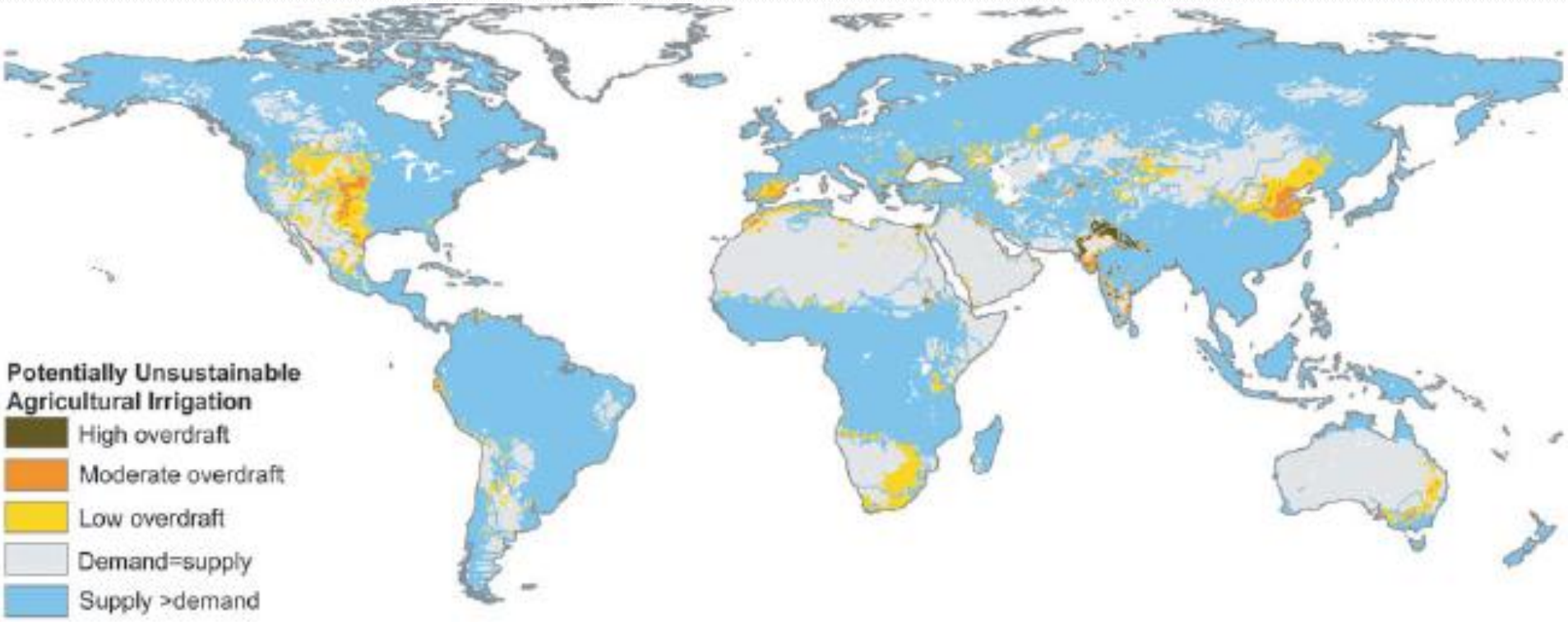

Source: Abramovitz 1996 (1)

**Figure 2.4—Irrigated land by region (and annual growth rate)**



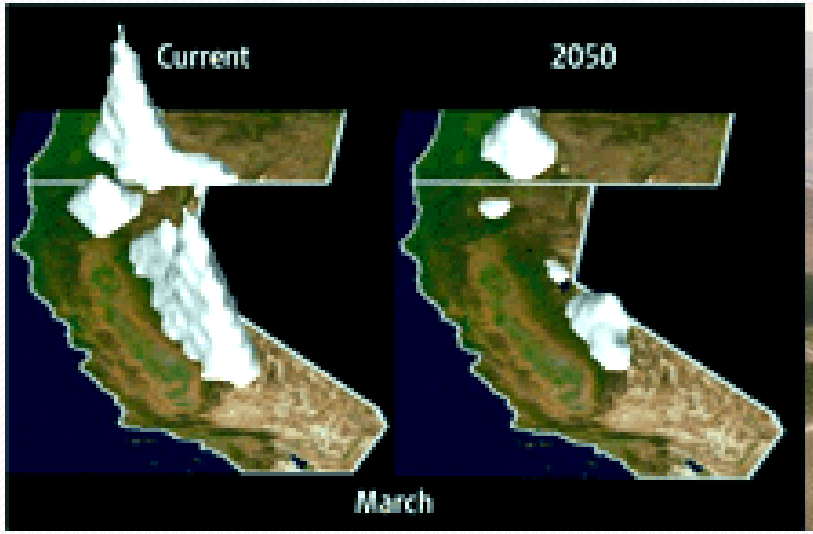

Source: ERS, based on data from FAOSTAT 9May02.

# Decreasing water supply in all major irrigated areas




**Yet, irrigated agriculture produces 40% of global food supply on just 18% of the cropped area.**

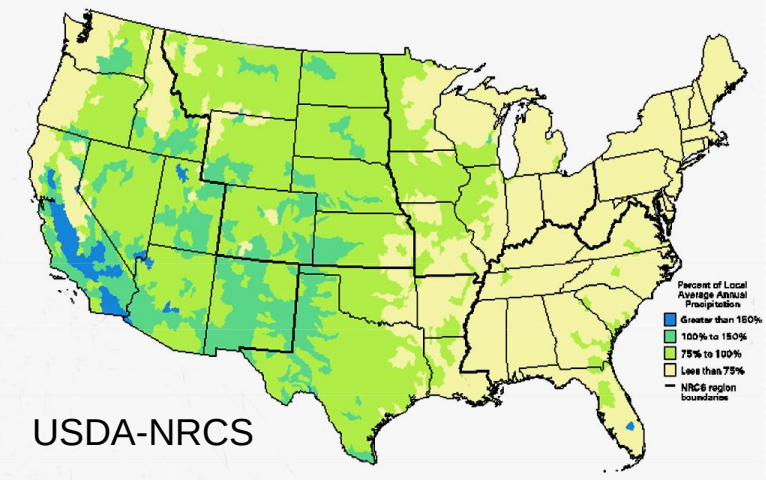
# Mountains / Snow / Water / Irrigation




California supplies ~50% of fresh fruits and vegetables for the United States. It can only supply these commodities through irrigation.

# People, Resources, Trends, and Challenges to Sustainability

## Freshwater Consumption as a Percentage of Local Average Annual Precipitation



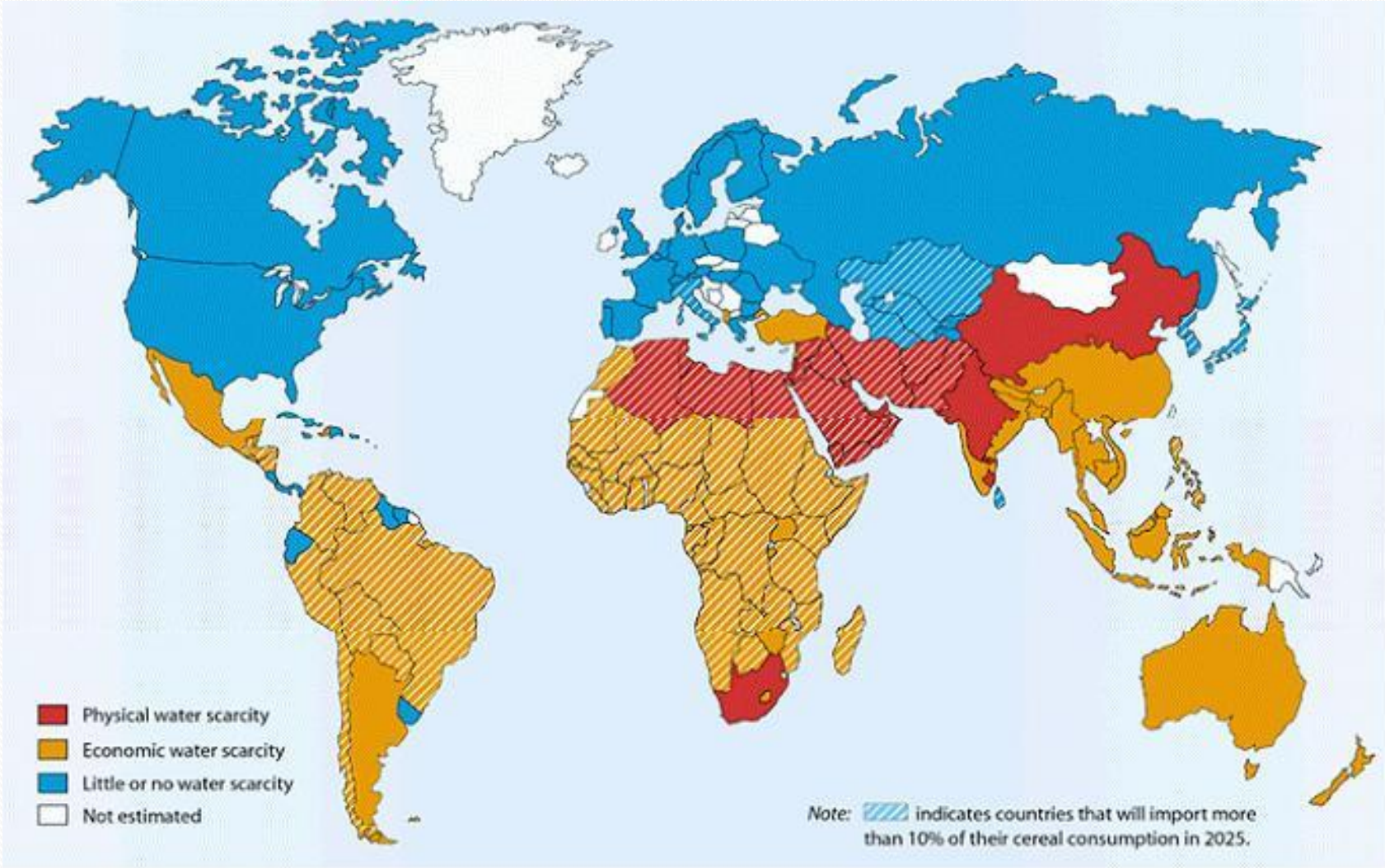

USDA-NRCS

- Greater limitations on water availability and quality.
- Increasing demand by growing cities and industries for water.
- Less water available in the western U.S. for agriculture.
- World requirements for water development may increase 57% by 2025.

USDA Economic Research Service

# Impact of Water Shortages

- Water quantity and quality
- Increasing global population ⇨ decreasing water availability
- Yemen: Water table falling 2 m per year
- Iran: Water table falling 2.8 m per year
- U.S. Southern Plains: Ogallala aquifer depleted
- Lake Chad: down 94% since the 1960's




www.iaea.org/.../water_supply_demand.html

Table A3. Water consumed for crop production and virtual water traded from various countries for year 1999, assuming an annual increase of 1% in water productivity. Values in $km^3$/year.

| Country | Water for crop production | Virtual Water imported | Virtual water exported | Net virtual water balance |
|---|---|---|---|---|
| Argentina | 114 | 3 | 69 | -66 |
| Australia | 64 | 3 | 85 | -82 |
| Brazil | 251 | 19 | 75 | -57 |
| Canada | 93 | 19 | 62 | -43 |
| China | 624 | 75 | 19 | 56 |
| Colombia | 23 | 8 | 4 | 4 |
| Egypt | 32 | 22 | 1 | 21 |
| Ethiopia | 11 | 1 | 0.04 | 1 |
| France | 103 | 43 | 91 | -48 |
| Germany | 75 | 64 | 63 | 1 |
| India | 423 | 31 | 8 | 23 |
| Indonesia | 422 | 36 | 8 | 27 |
| Mexico | 47 | 54 | 5 | 49 |
| Nigeria | 47 | 8 | 0.3 | 7 |
| Pakistan | 56 | 15 | 4 | 11 |
| Russian Federation | 93 | 49 | 4 | 45 |
| UK | 35 | 43 | 22 | 21 |
| USA | 502 | 65 | 234 | -169 |

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http://www.worldwatercouncil.org/fileadmin/wwc/Programs/Virtual_Water/VirtualWater_article_DZDR.pdf

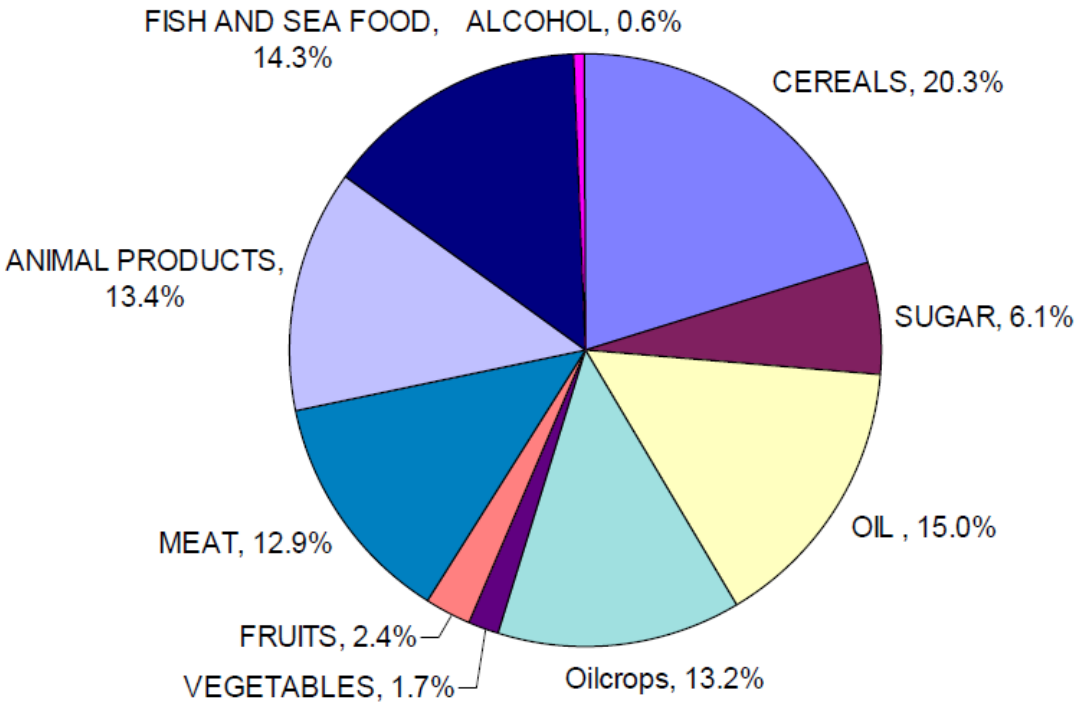


Figure 6. Global virtual water food trade in 2000 (1 340 km3).

- ***Note Accomplishments to Date***: ***Accomplishments with tremendous impact have been the sequencing of the cattle genome, development of the 50,000 marker chip for genotyping, and application of these new tools to dairy cattle improvement. An immediate impact has been reducing the cost of sire evaluation from $25-50,000 to $300, while simultaneously increasing the accuracy of evaluation by 50%, and speeding the rate of improvement by over 50%.***






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