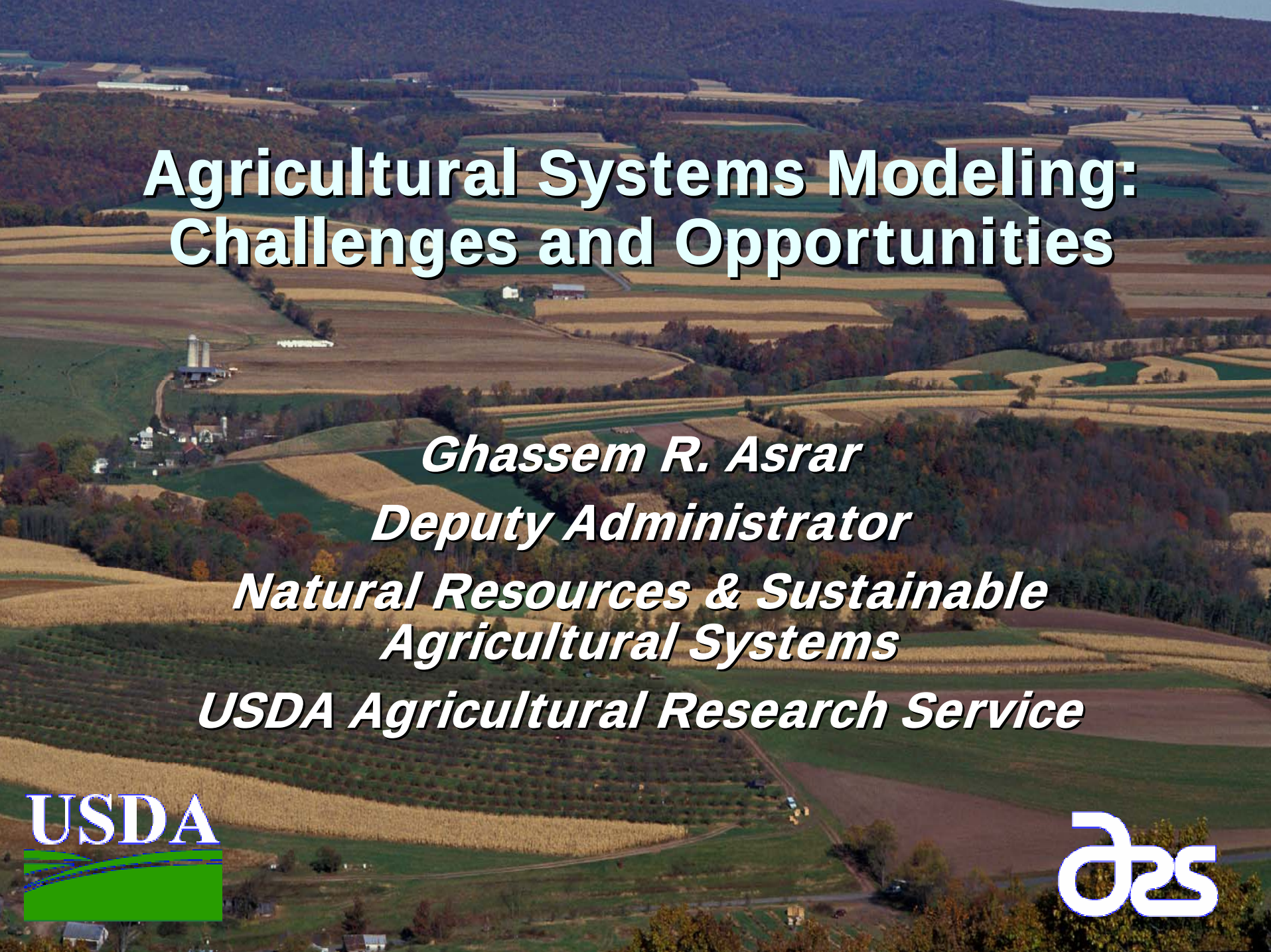


Agricultural Systems Modeling: Challenges and Opportunities

Ghassem R. Asrar

Deputy Administrator

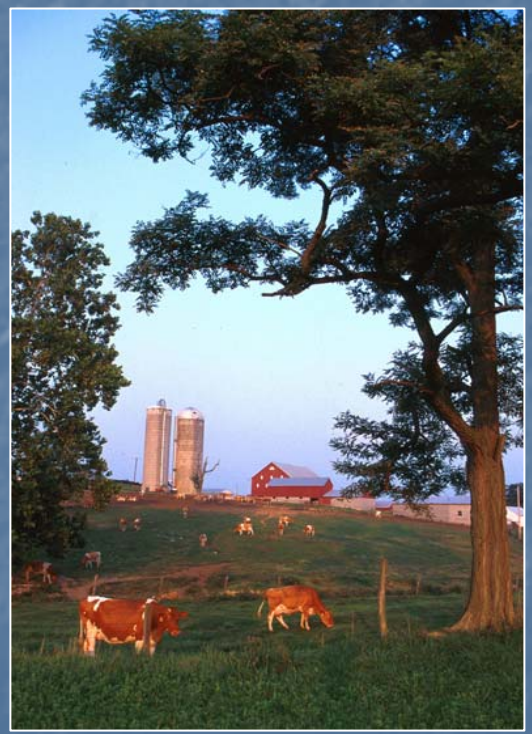
Natural Resources & Sustainable Agricultural Systems

USDA Agricultural Research Service

USDA

ARS

Agricultural Science Contributions



American Agriculture's Accomplishments:

- 16% of the $9 trillion gross domestic product
- 8% of U.S. exports in 2006
- 17% of employment
- < 2% U.S. workforce on farms
- 100% of the citizens are users

Agricultural Science Contributions

Research has enabled increased production through:

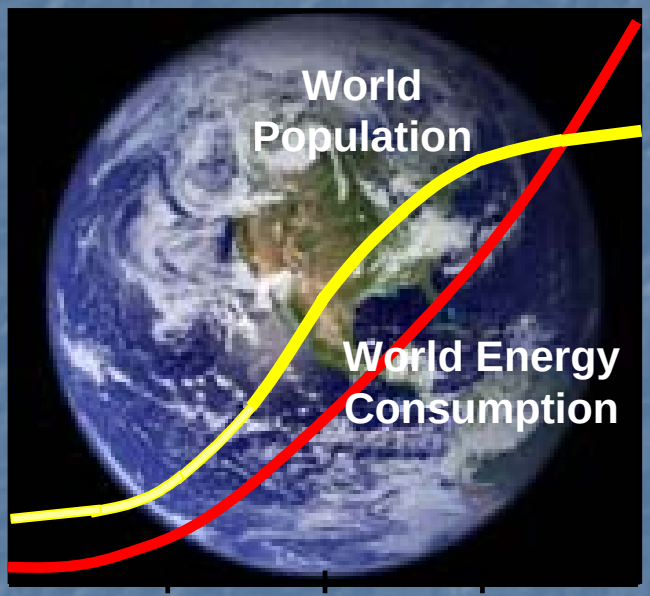
- Genetics and plant breeding.
- Agricultural mechanization.
- Efficient use of fertilizers, agrochemicals and water.
- Irrigation and drainage technologies.
- Use of antibiotics
- Aquaculture

Agricultural Science Contributions

Research has also helped producers address:

- Natural resource stewardship.
- Changing market conditions.
- New technology introductions.
- Major agricultural concerns (i.e. diseases, pests, invasive species, etc.)

Agricultural Science: Challenges and Opportunities



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.
- Addressing food safety and security.

Agricultural Science: Challenges and Opportunities

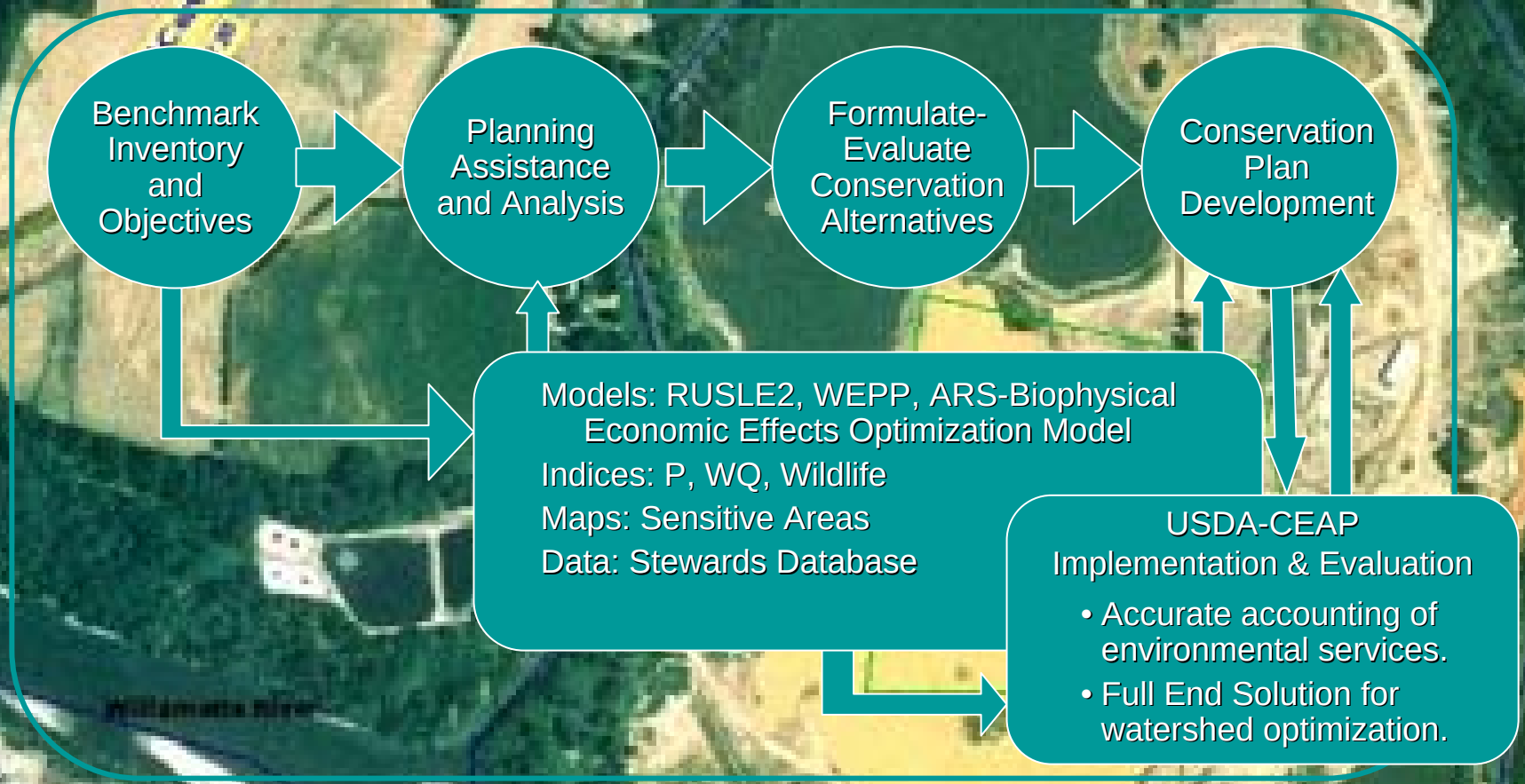
Challenges Ahead:

- Decision making is no longer limited to single-factor effects.
- Complex problems require holistic solutions.
- Multifunctional assessment of agricultural ecosystems
- Problem-solving requires a systems approach.
- Need to look across disciplines and national program boundaries for partnerships.

Soil and Water Assessment Tools SWAT

- **International Partners**
  - 10 countries helping to improve the model
  - 35 countries are currently using the model
- SWAT was the tool chosen to quantify the environmental benefits of conservation practices at national and watershed scales for the Conservation Effects Assessment Project (CEAP)
- *ARS is committed to enhancing SWAT and making it available to its partners through collaborative efforts*

Planning Tools that Document the Benefits of Conservation Practices at Field and Watershed-Scales



Conservation Effects Assessment Project (CEAP)

Quantify Environmental Benefits of Conservation Practices

- Estimate the ***benefits*** of current conservation practices.
- Estimate the ***need*** for future conservation practices.
- Simulate ***alternative options*** for implementing conservation programs on croplands and rangelands.

Conservation Effects Assessment Project

Plant residue management and structural conservation practices currently in use:

- Reduce sediment loss by 58%, from 3 to 1.3 tons/ac/yr.
- Reduce phosphorous loss by 43%, from 3.5 to 2 lbs/ac/yr.
- Reduce nitrogen loss by 25%, from 25 to 19 lbs/ac/yr.
- Reduce pesticide loss by 19%, from 18 to 15 gr/ha/yr.
- Reduce wind erosion on vulnerable lands by 28%.
- Increase soil organic carbon by 25%, 195 lbs/ac/yr.

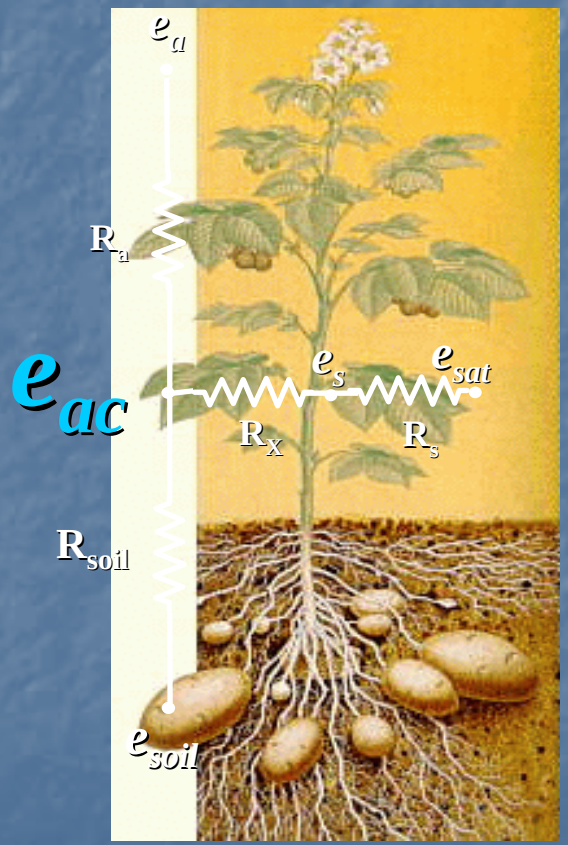
CEAP has identified 129 million acres in need of conservation practices for consistent environmental benefits/ protection.

This is 43% of cultivated croplands in U.S.

Models Can Address Agricultural Systems Questions

- What are the consequences of climate change on agricultural production?
- What would be the effect of regional drought on agriculture and ecosystem services?
- How can natural resource quality be best managed while achieving production goals?
- What are adaptation and mitigation approaches to agricultural production in 21st Century?

Challenges/Opportunities

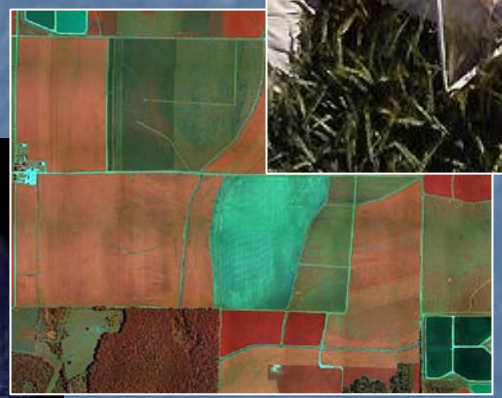


<u>Models Must</u>: Realistically represent natural processes and complexity.

- **Biological**
- **Physical**
- **Biochemical**
- **Economic**
- **Other constraints**

Challenges/Opportunities

Models Must: Be able to handle scales across space and time.



Cell-Plant

↕

Field-Farm

↕

Watershed-Region

↕

National-Global

Challenges/Opportunities

Models Must: Be rigorously validated to ensure confidence in their results and maintain credibility.

- **Across ecological regions**
- **In a variety of management systems**
- **At scales from within-field to regional, national and/or global**

Challenges / Opportunities

Models Must: Be able to operate using real-world observations that are not "research quality":

- Standard weather data
- Soil survey maps
- Routine user-collected samples
- Observations collected by volunteers
- Models must also be able to accommodate observations from national/global networks

Challenges/Opportunities

<u>Models Must</u>: Produce results that can be applied to a variety of needs specified by the user community.

Agricultural Producers & Consultants

Strategic Decision Makers

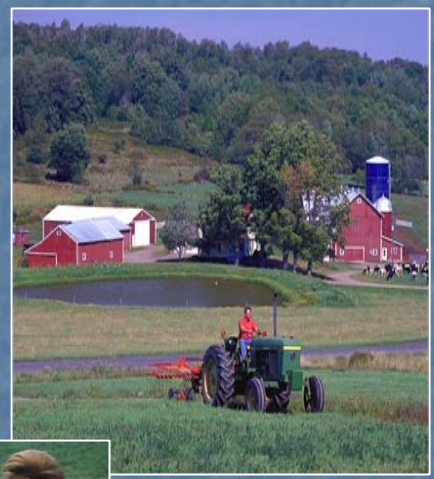
Government Action Agencies

Research Community

Challenges/Opportunities

Models Must: Be developed based on common standards and protocols for ease of use:

- **Custom documentation**
- **Software with GUI**
- **Multiple output forms**
- **Web data exchange protocols**



Water Supply Forecasting at the National Water and Climate Center (NWCC)

- Objective
  - Provide more accurate, physical process-based, streamflow forecasts using the Precipitation Runoff Modeling System (PRMS) for agricultural water management in the western US.
- Method
  - Implement the PRMS model and its components in the Object Modeling System (OMS) integrated with climate data and streamflow data.
  - Leverage and Deploy OMS tools for Model Calibration, Ensemble Streamflow Prediction, Visualization, and Analysis in an automated and operational environment at the NWCC
  - Provide an extensible, flexible modeling framework and an open environment for collaborative model development and operation.

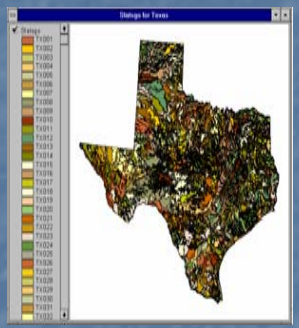
Simulation Modeling Needs

To meet the National Goal of assessing "Clean and Abundant Water," by providing:

- Peak flow forecasts
- Dates for critical threshold (low/high) exceedances
- More frequent hydrograph forecasts at critical times during the melt and growing season
- Seasonal extended streamflow forecasts that incorporate short and medium-range climate forecasts
- Long-term (decadal) streamflow forecasts that incorporate climate change scenarios for natural resource planning
- Scenarios for natural resource planning

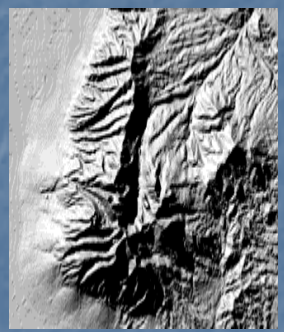
Partnerships are Essential for Success

Soils

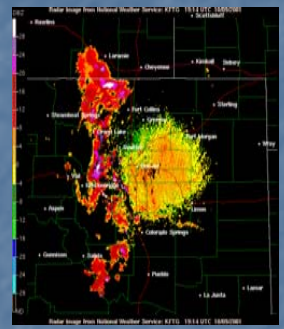


Hydrology

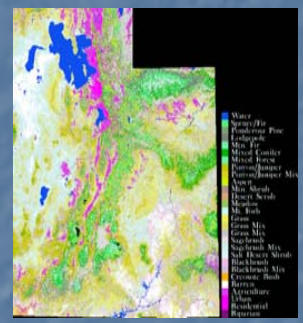
Topography



Climate



Land Use



Partnerships are essential to improve:

- **Observational capabilities**
- **Modeling capabilities**
- **Support users' inquiries**

We value and welcome greater partnerships in development and applications of SWAT

Natural Resources are the foundation of life– a basic requirement for agricultural, economical , industrial and societal developments.


Agricultural Science: a key to food and energy security and natural resources stewardship in 21st Century.
L = Light Milled D = Deep Milled
24
12
0
-12
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Factor 2
USDA
ars