USDA Integrated Approaches and Resources for Erosion Prediction and Control in Sustainable Farming Systems

Linda Oyer Scheffe and David T. Lightle

USDA INTEGRATED APPROACHES AND RESOURCES FOR EROSION PREDICTION AND CONTROL IN SUSTAINABLE FARMING SYSTEMS

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Global reduction in agricultural productivity due to soil erosion and degradation, depletion of irrigation water supplies, and competing land uses is limiting our capacity to meet increasing world-wide demand for food and fiber. Estimated water (sheet and rill) erosion on cropland declined from 1.68 billion tons per year (4 tons/acre/year) in 1982 to 960 million tons per year (2.7 tons/acre/year) in 2007 in the United States. Despite this decline in erosion rates, water erosion is still one of the most predominant resource concerns facing producers and conservation planners. Roughly 99 million acres (28% of all cropland) are eroding above soil loss tolerance (T) rates.

Integrated approaches are required to achieve a sustainable farming system of soil, water, air, plant, animal, and human resources. The key approach to achieving integrated sustainable management is to think system (ecosystem, whole farm, and watershed), think critically (connect the dots), actively seek resource opportunities, emphasize technology "exchange" vs. "transfer" with other producers and partners, plan creatively and flexibly, and focus on keeping energy flow through the integrated system. Case studies, field trials, demonstrations are all important approaches for technology exchange. Interdisciplinary teams including producers and partners are essential in developing integrated sustainable farming systems.

The U.S. Department of Agriculture provides interagency resource inventory, research, technical assistance and training for planners, partners and producers on "how-to" evaluate and understand site-specific field conditions, including chemical, biological and physical. This enables us to evaluate and implement best management practices/approaches for erosion control within an integrated farming system. Considering how the farm fits into broader watershed management (e.g. off-site effects and resource opportunities) is also essential to problem-posing and problem-solving resource management success and development of sustainable communities. Building soil quality is the key to building soil, water, air, plant, and animal resources. Practical applications, integrated approaches and tools, and potential effects of conservation practices on soil erosion and soil quality will be provided.

The Revised Universal Soil Loss Equation version 2 (RUSLE2) is a process-based model that predicts long-term average annual soil loss for a given set of climatic conditions, on a defined land slope, and under a specified cropping and tillage management system. RUSLE2 can be used to predict the erosion and soil quality benefits of conservation cropping and management systems.

The in-progress NRCS Sustainable Cropping Systems Handbook lays out an integrated framework for understanding and improving soil quality, water quality, air quality, nutrient and salinity management, crop yield and quality, irrigation water management, integrated pest management, and long term soil productivity. The Web Soil Survey places local soil maps, descriptions, data, suitability ratings, and interpretations in the hands of users.

The multi-agency "Soil Change Guide: Procedures for Soil Survey and Resource Inventory" and "Interagency Ecological Site Description Manual" provide systematic procedures for examining, quantifying, dynamics within soils and plant communities. In addition, they provide systems to record observations, data management schema and ways to analyze relationships and develop trends and risk models.

These new resources provide the tools for conservationists to assess soil health and develop long-term sustainable conservation plans for our nation's, and potentially our world's, farms and ranches.

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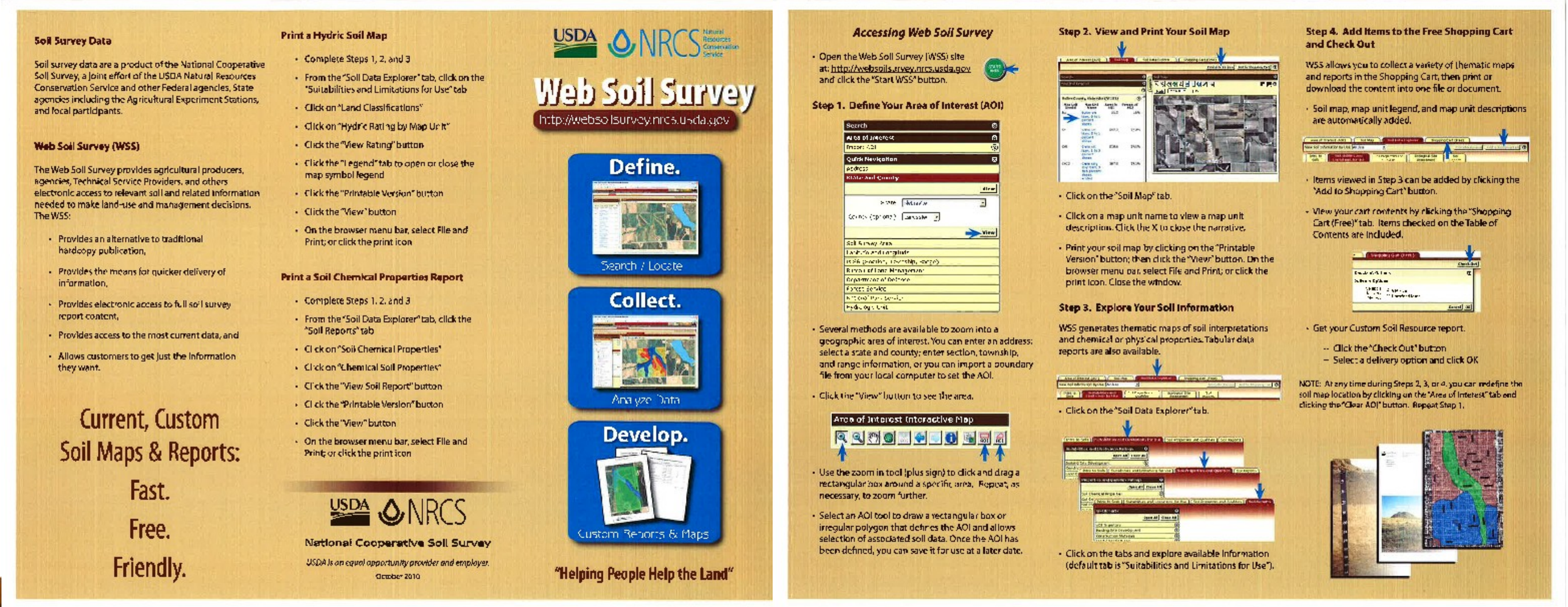
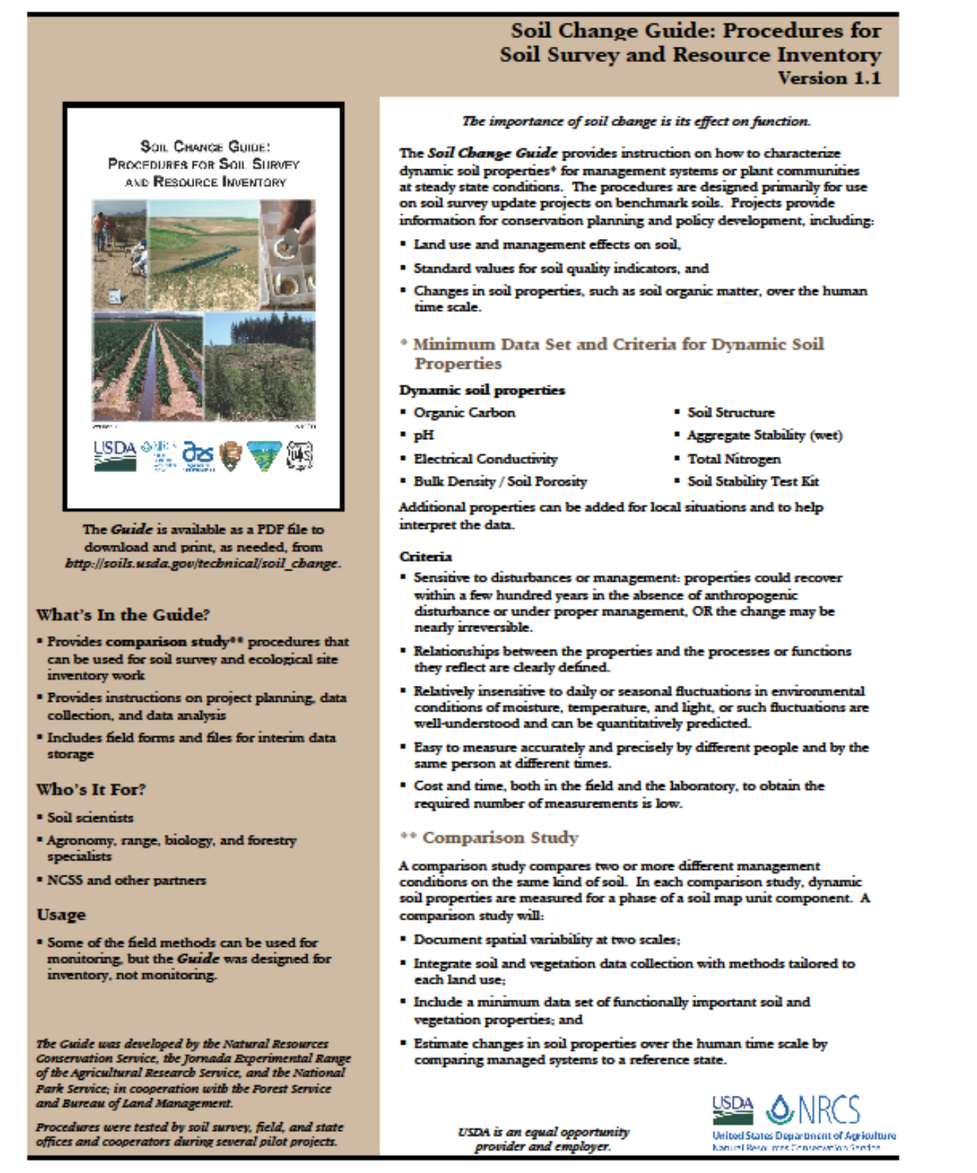
Build Soil Quality

- Minimize or eliminate tillage
- Apply nutrients according to soil, plant, tissue tests and nutrient budget
- Increase on-farm nutrient cycling, plant species diversity
- Maintain ground cover year round by using cover crops and mulches and by leaving crop residues in field
- Manage/protect soil organisms preserve biodiversity
- Rotational grazing, prescribed grazing

Sustainable Farming – Maximize Biodiversity

- Integrate crop and livestock production
- Use hedgerows, insectary plants, cover crops, etc. to attract beneficial insects, bats, and birds
- Plant trees and perennial crops
- Abandon monocropping in favor of crop rotations, intercropping and polycultures
- Manage pastures to support diverse selection of forage plants
- Plant cover crops





Integrated Irrigation/Nutrient/Residue/Salinity Management/Soil Quality Field Trials/Demos

NM Integrated Cropping Systems and Water Mgt Handbook

http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/nmiwm.html, July 2008

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Integrated Erosion Management

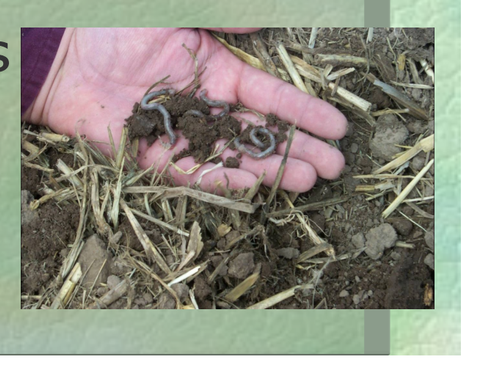
- Integral part of complete farm management program of soil, water, air, plant and animal resources
- Process of preventing and controlling wind and water erosion through integrated approaches
- Evaluate and implement alternative best management practices for erosion management within an integrated system
- End result a more economical, sustainable, and producer-acceptable farming enterprise

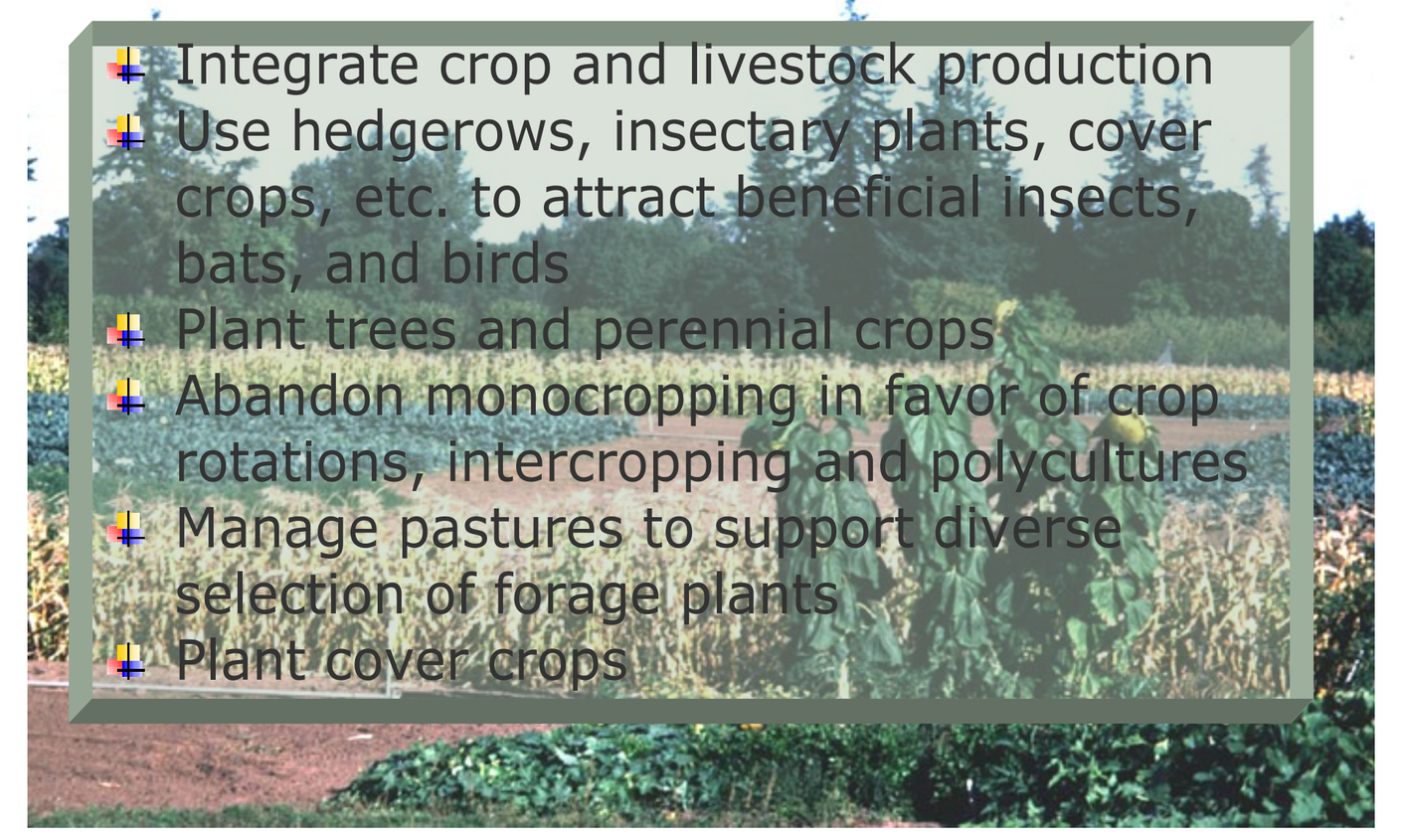
Manage Pests Ecologically

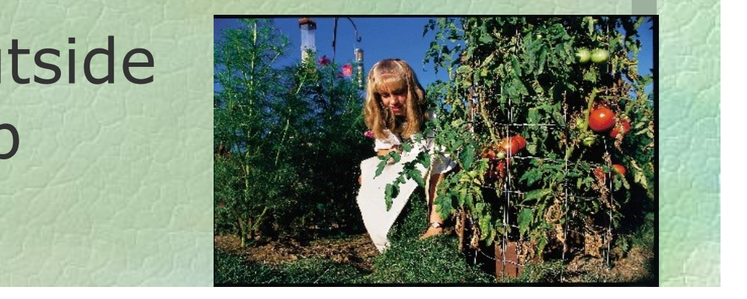
- Prevent pest problems by building healthy, biologically active soil, creating habitat for beneficial organisms, and choosing appropriate plant cultivars/rotations
- Tolerate, don't eradicate
- There is no silver bullet
- Treat the causes of pest outbreaks, not the symptoms
- If you kill the natural enemies, you inherit their job

Develop Conservation Plan

- Use integrated approach to inventory resources and develop conservation plan for whole farm
- Choose and apply conservation practices, technologies, approaches to address identified resource concerns and take advantage of opportunities
- Not only think outside the box, but step outside the box







Sustainable Farming Systems must integrate:

- Soil Quality, including Soil Erosion
- Water Quality
- Nutrient and Salinity Management
- Cropping Systems, incl. Cover Crops
- Irrigation Water Management and Systems
- Integrated Pest Management
- Livestock and Wildlife
- Energy and Air Quality
- Economics
- Whole Farm Planning
- Watershed, Marketing Opportunities

Potential Benefits of Sustainable Systems: Water Resource

- Conserved surface and ground water quantity and quality
- Increased efficiency, higher yields
- Reduced pumping costs
- Water losses minimized (evaporation, runoff and deep percolation)

Potential Benefits of Sustainable Systems: Soil Resource

- Improved soil quality (greater yields, more crop biomass/residues, improved soil structure, organic matter)
- Reduced wind and water erosion
- Proper salinity and nutrient management (reduced use of soil amendments, reduced runoff and leaching)

Potential Benefits: Plant Resource

- Crop production costs reduced
- Increased crop yield and quality
- Reduced pest incidences (e.g. weeds, insects, diseases)
- Available water quantity and quality meet specific requirements of crop (consumptive use, leaching)

Other Potential Benefits

- Reduced overall on-farm energy use
- Increased beneficial use of fertilizer and soil amendment inputs
- Protection of resources by planned judicious use of water and all inputs
- Record keeping is used as a tool in decision-making and management of current and future water resources

Other Considerations

- Take an inventory; think about every field/pasture/stream/well
- What are the natural resources on my farm? In my watershed?
- What crops and rotations can I grow/use?
- Besides using crop residues and cover crops, what other practices can I apply to build soil quality? To recycle nutrients? To use water efficiently? To reduce disease/pest problems?
- Have I minimized runoff and leaching? Am I protecting soil, water, air, plant, animal resources?
- How can I integrate livestock/wildlife on my farm?
- Which practices would contribute to an environmentally and economically sound farm?
- Have I taken a soil, water, tissue test? Am I making the best use of compost, animal manure, legumes as nutrients for plants and to build soil quality?
- How can I conserve/produce energy or reduce energy use?

Develop a Case Study/Conservation Plan

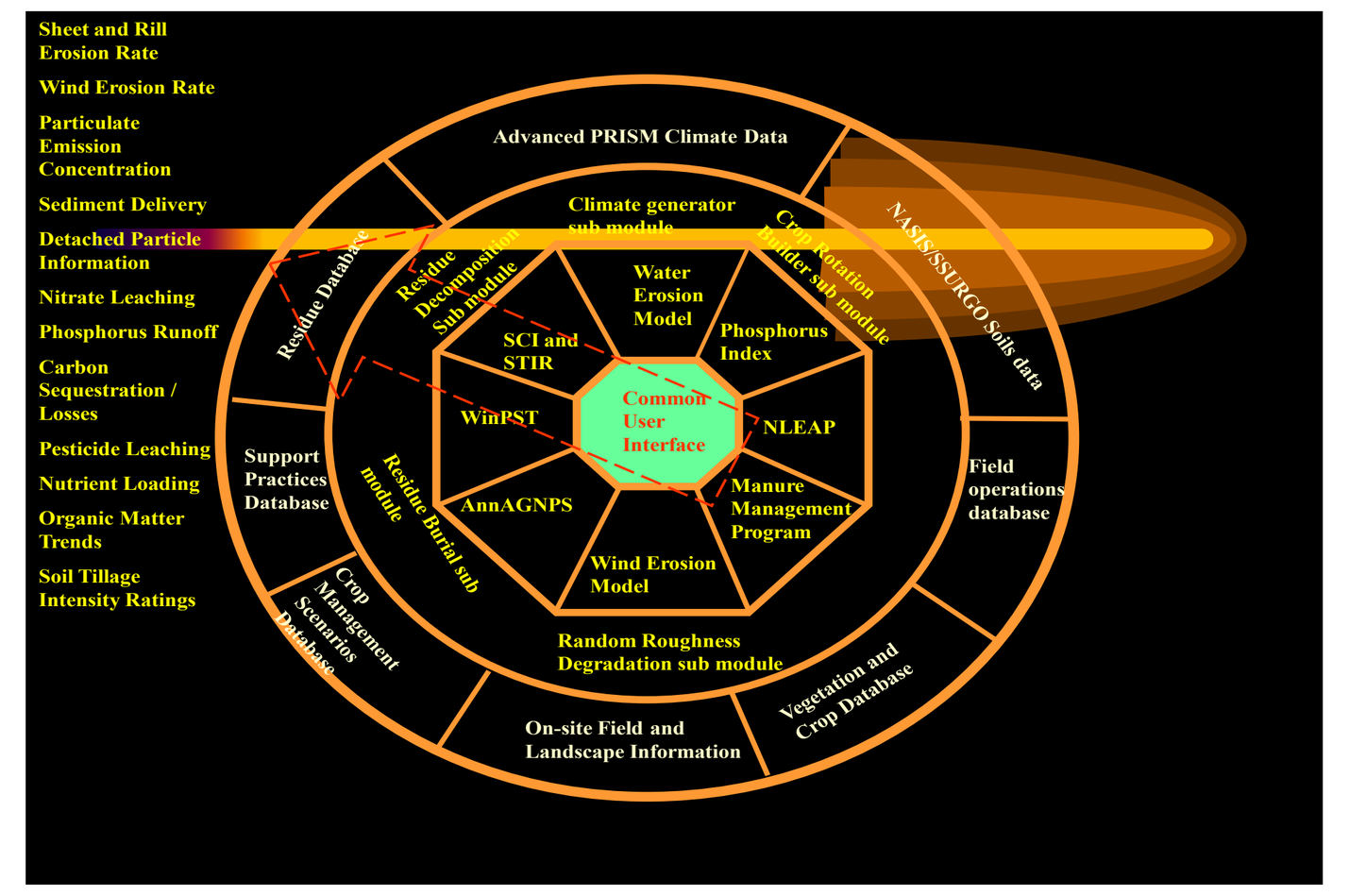
Producer Sustainable Workshops

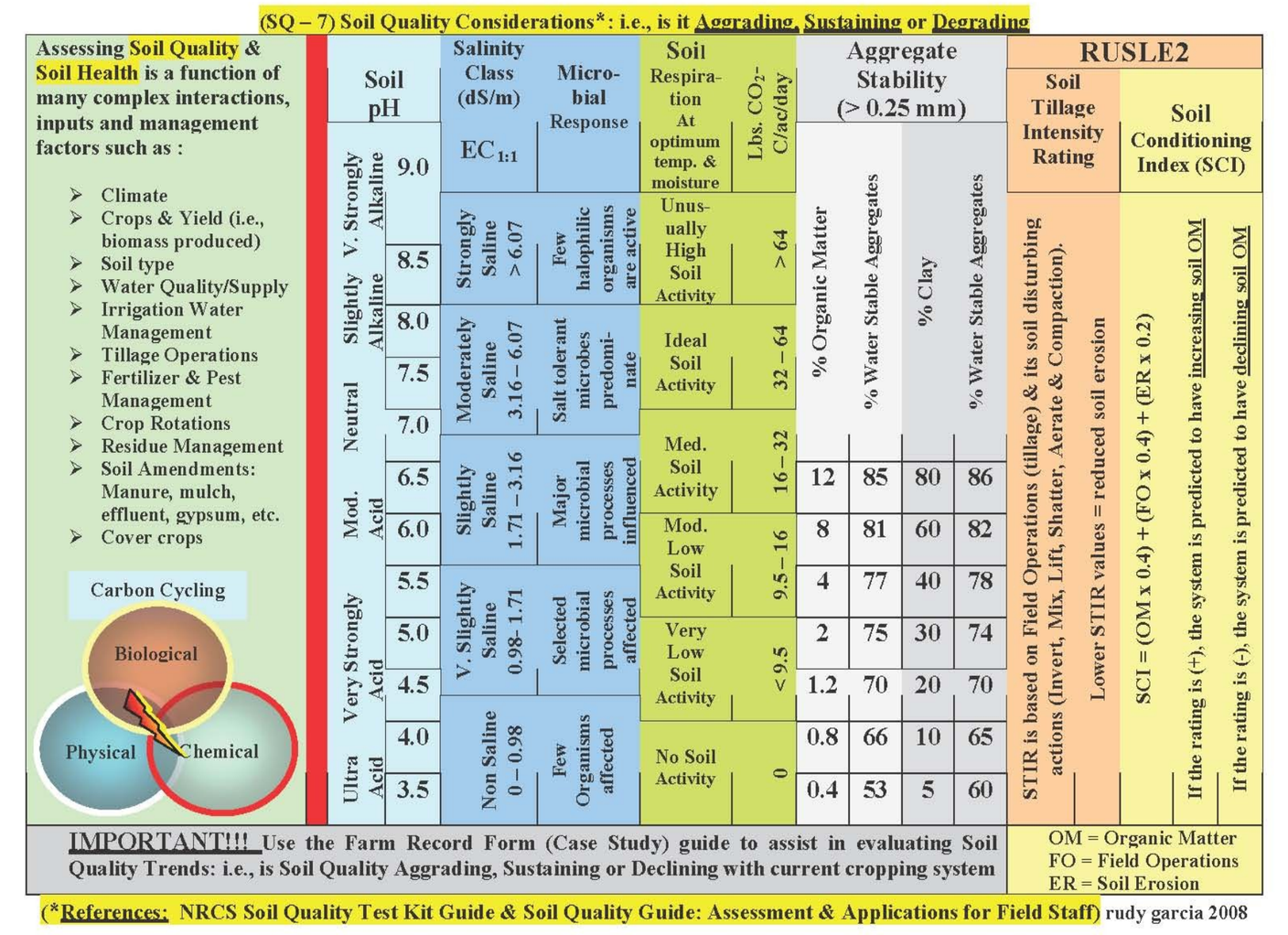
Resource Inventory Includes:

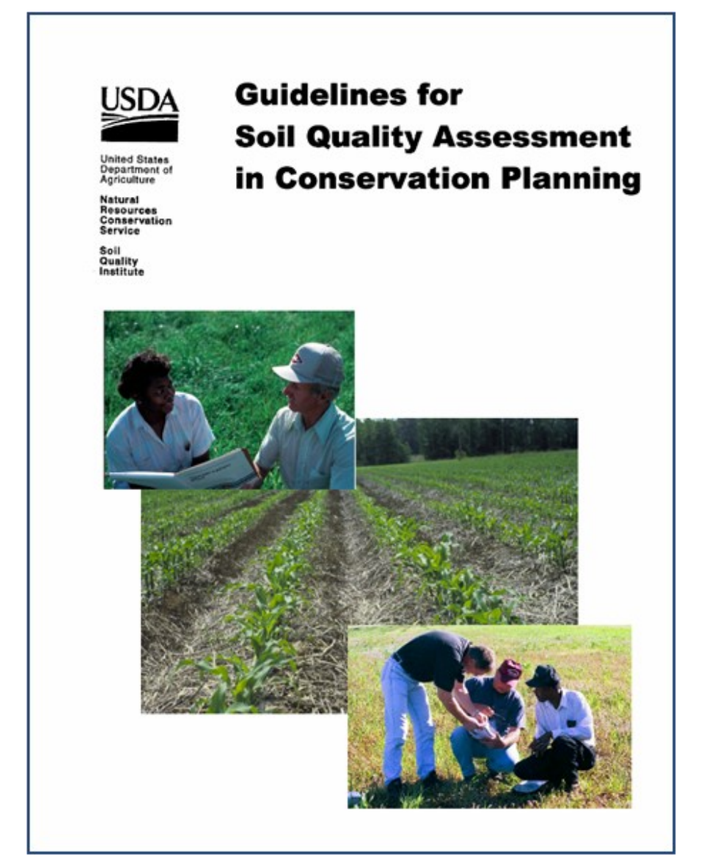
- Irrigation Water Samples
- Soil Samples
- Plant Tissue Samples
- Irrigation System evaluation
- Soil Texture, Structure and, most importantly, Aggregate Stability
- Tillage Operations
- Fertility Inputs
- IPM
- Cover Crops
- Crop Rotations

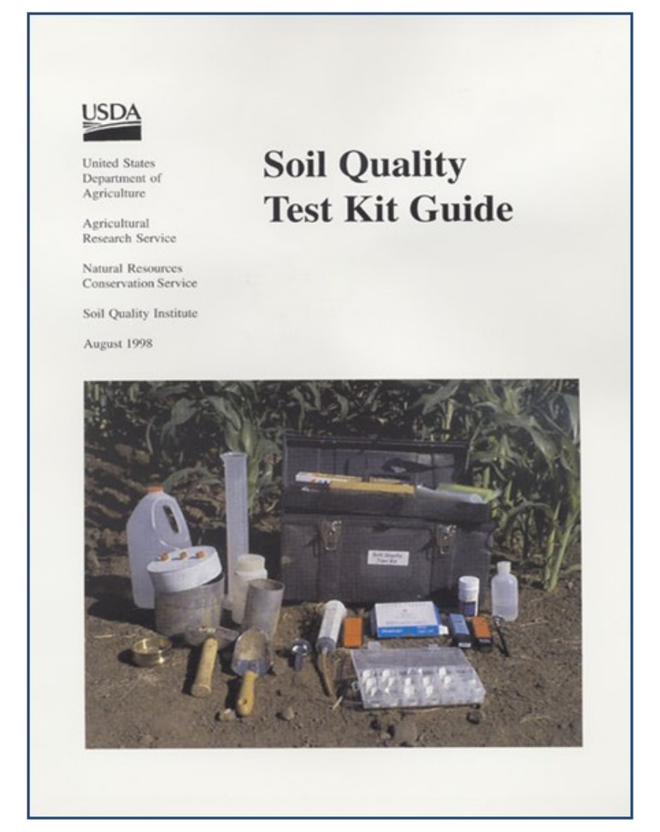
Integrated Erosion Tool

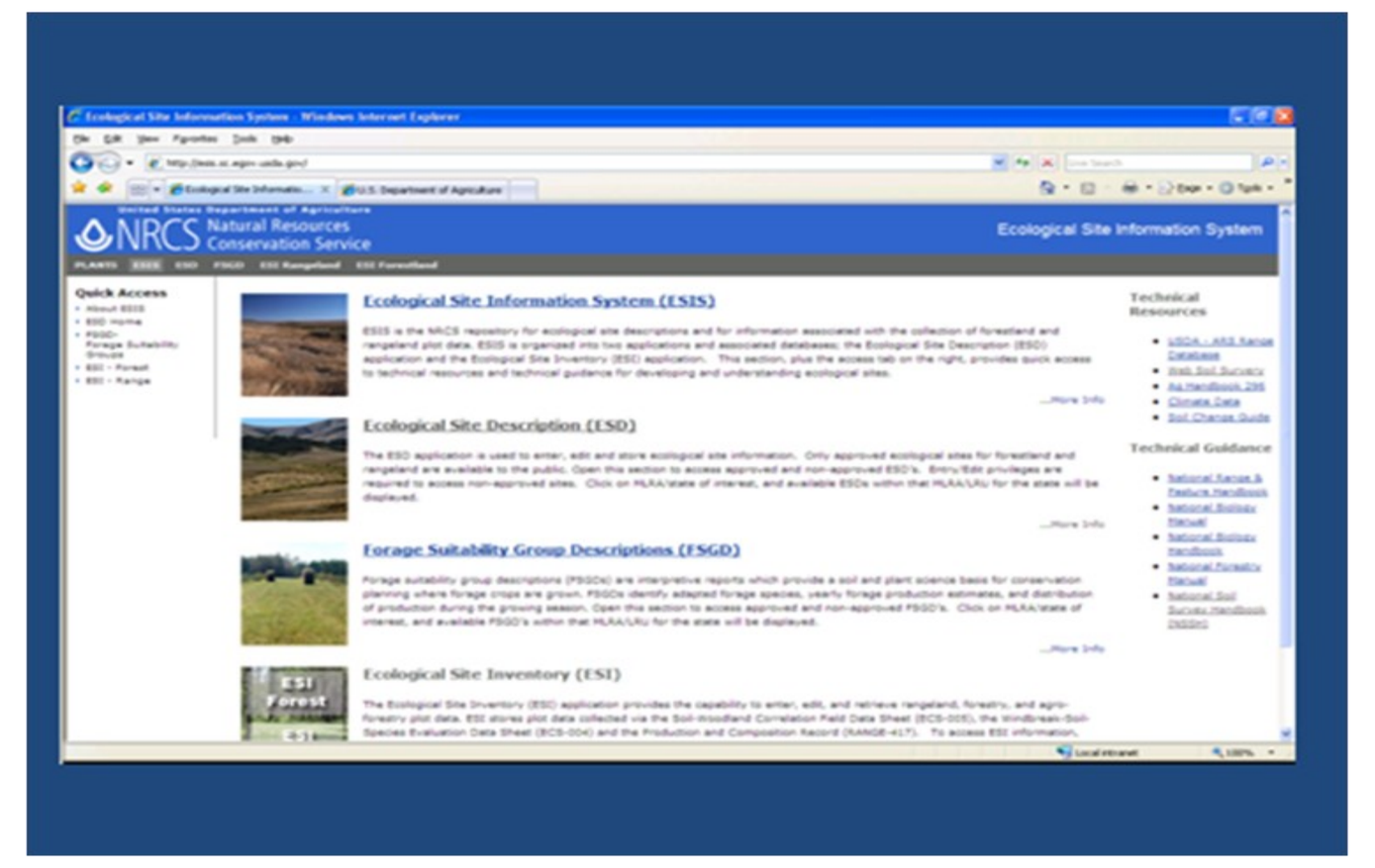
- Each agronomic, including water and wind erosion, model currently contains it own databases
- Most utilize similar data
  - Soil map unit and component data
  - Climate location data on temperature, precipitation and wind energy
  - Crop and plant data, Crop Management Scenarios
  - Tillage, pesticide, nutrient and manure application, planting and harvest operations
- NRCS has been developing, trying to maintain and serve up separate databases for each model; now transitioning to one database (Land Management Operations Database) and developing an integrated erosion tool



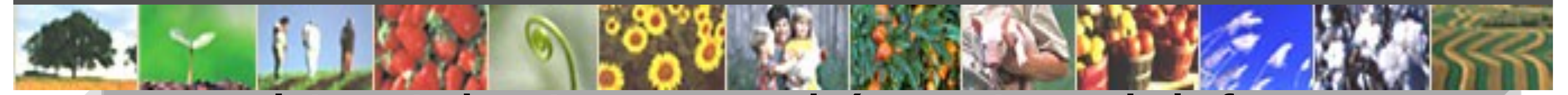








Keys to Achieving Sustainable Farming



- use integrated systems approach (ecosystem, whole farm, watershed); use integrated tools to assess resource concerns
- problem-posing, problem-solving
- actively seek resource, watershed, marketing opportunities
- resource efficient and resource conserving
- technology "exchange" vs. "transfer"
- develop whole farm conservation plan creatively and flexibly, step outside the box
- consider on-site and off-site effects
- focus on keeping energy flow through the integrated system
- reemphasize biological factors, improve biodiversity
- improving soil quality is key to improving soil, water, air, plant, and animal resources
- case studies, field trials, on-farm research/demonstrations, farmer-to-farmer networks
- interdisciplinary teams including producers and partners
- farmers need to demand quality service
- recordkeeping is tool in decision-making and management of current and future resources
- need user friendly fact sheets, brochures on integrated systems