Case Study: ARS Research on Water Quality and Watersheds

Assessing the Benefits of ARS R&D within an Economic Framework

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ARS Research on Water Quality and Watersheds

- National Program 211
  - “Water Availability and Watershed Management”
- Formerly organized under NP 201
  - “Water Resource Management”
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RESEARCH ACTIVITIES
EVALUATION CONCEPTS
CONCLUSIONS
ARS water research combines several elements of our analysis

- Market failure paradigm
  - Problems in water quantity markets
  - Water quality is essentially nonmarket

- Mission paradigm
  - “Enhance the natural resource base and the environment”
  - “Sustain a competitive agricultural economy”
  - Research supports other USDA programs
Many water use/water quality decisions take place outside functioning markets

- Water quality actors do not transact directly
  - Environmental benefits, services not rewarded
  - Water quality impairments not penalized
- Primary users of some ARS research include other USDA, Federal, and state agencies
- Lack of economically significant prices, quantities a challenge for economic evaluation
Water research suggests opportunities for evaluation in programmatic review

- Definition of counterfactual scenarios
- Inferring research value from policy context
  - Conservation Effects Assessment Project (CEAP)
- Small-bore studies on specific areas of interest are possible
  - Focused studies for specific topics
  - Narrow spatial effects
- Internal evaluation
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Why water quality and watersheds?

- Rounds out the scope of ARS research
  - Natural Resources and Sustainable Agricultural Systems
- Examines the “market failure” paradigm in an area of environmental externalities
- Illustrates interaction of science with policy; supports ARS mission areas
Physical, economic, and social properties of water present difficult issues

- Physical properties:
  - Universal solvent: problems are difficult to contain
  - Surface, subsurface, atmospheric channels
  - Nonpoint source: sources are difficult to establish

- As a commodity, barriers to market efficiency
  - Seasonal, regional correlation of supply and demand
  - Low total value to weight
  - Complex historical, legal allocation of property rights

- Universal necessity: Water used in every sphere of human activity
  - Each sector of use may have different, competing requirements
  - Multidisciplinary research
  - Multiple regulatory authorities
With such a broad topic, we tried to narrow the field somewhat.

- Wanted to focus on water quality rather than water quantity/irrigation
  - Away from water-as-commodity
  - Towards market failure paradigm
- Difficult to separate water quality and quantity in practice
In the end, we focused on a few research activities with a water quality emphasis:

- Biophysical models of water and pollutant processes
- Subsurface drainage
- Watershed studies
Water Quality Pollutants

Sediment

Nutrients
Water Quality Pollutants

Sediment Nutrients Pesticides
Water Quality Pollutants

Sediment Nutrients Pesticides Pathogens
Water Quality Pollutants

Sediment  Nutrients  Pesticides  Pathogens  Salts
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Current water quality emphasis evolved from historical USDA research

- Research on soil productivity and erosion date back to the creation of the USDA
  - Prevention of soil loss, erosion, salinity
  - Optimal application of nutrients
- “Tile drain” systems expanded rapidly after the Civil War
- All three areas have modern precursors dating from at least the 1950s
- Illustrates long research lags, changing paradigms
Biophysical models are multidisciplinary efforts in widespread use

- Model the sources and effects of water quality pollutants
  - Rainfall, temperature, soil types, agricultural practices, physical and biological processes
- Models available free of charge
- Large networks of researchers improve, integrate, and customize models
  - Universities, other public agencies
  - Some secondary use: state environmental agencies, consultants, international users
- Often directed to other USDA agencies, but applied widely throughout Federal government
(2) Subsurface drainage

- Subsurface drains manage water tables for
  - Productivity
  - Runoff
  - Salinity
  - Irrigation

- Extensively used in large areas of US

- Represented in some biophysical models
  - RZWQM, DRAINMOD, ...
(3) Watershed studies provide necessary spatial scale for ag water quality effects

- Hydrologic, biologic processes occur over large areas
- Nonpoint sources and competing uses are regional
- Incorporates regional farming practices

1990 HUA: Hydrologic Unit Areas
1990 MSEA: Management Systems Evaluation Areas
2003 CEAP: Conservation Effects Assessment Project watershed studies
Conservation Effects Assessment Project (CEAP)
USDA water research spending 1973-2003

Millions $2003

Source: CRIS data, ERS

Federal Ag Water Spending ($2003)

Source: CRIS data, ERS
ARS research funds fewer projects, in more research problem areas (RPA)

<table>
<thead>
<tr>
<th>Funding Type</th>
<th>Projects</th>
<th>$2003/ Project</th>
<th>RPAs/ Project</th>
<th>RPA “span”</th>
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<td>Formula Funds</td>
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<td>ARS</td>
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<td>Coop’ative Agreement</td>
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<td>Comptitive Grant</td>
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<td>Other</td>
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</table>

*”Span” := # of RPAs funded relative to 158 total RPAs addressed

Source: CRIS data, ERS
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Biophysical models are important tools for identifying counterfactuals

- Biophysical models provide a baseline for evaluating new technologies and policies
  - Only one set of facts is observed, but many factors change simultaneously
- Important for “opportunity cost”:
  - What was the best alternative?
- How to evaluate an evaluation tool?
Environmental “targeting”: allocating program dollars for greater efficiency

- An application of models to achieve
  - Greater benefit per program dollar
  - Lower costs to achieve a desired performance
- Identifies physical impacts with greater economic significance (pos. or neg.)
  - Practices with cost-effective implementation
  - Sources that are particularly damaging
  - CRP, EQIP incorporate this approach to a limited extent
- At a minimum, research benefit is the difference “targeted” vs. untargeted policy
Inferring program benefits from policy context has attribution problems

- Incomplete attribution of benefits
  - Multidisciplinary, multisector problem
  - Basic vs applied, long lags

- Superattribution of benefits
  - Sum of marginal contributions can exceed total benefit
  - Occurs when multiple actors are indispensable:
    - ARS technology
    - CRP policy
    - Remote sensing data
    - Producer consent

How to value the marginal contributions?
Conservation Effects Assessment Project (CEAP)

- Simultaneous with 2002 Farm Bill expansion of conservation programs
- Representative spatial sample of croplands in grain, integrated analysis of farming practices
  - Rangeland, wetland components
- Watershed studies
- Literature review
  - Includes numerous smaller studies
Greater precision in benefits estimation narrows the scope of evaluation

- Spatial focus for more complete accounting
  - Market, non-market values vary spatially
  - GIS is a complementary tool
- Methodology for hard-to-measure effects has greater costs, data needs
  - Stated preference
    - Contingent valuation
  - Revealed preference
    - Travel cost, hedonic analysis
  - Economic experiments
- Do results generalize sufficiently for programmatic analysis?
Internal program evaluation is an area for application of economic analysis

- Research planning and management continue, whether external economic information is available or not
  - Reliance on peer review, achievement of milestones, other program planning tools
- Economic analysis can lend insight; examples from ARS programs:
  - Leveraging existing assets (human capital, experimental sites, etc.)
  - Reallocating marginal funds
  - “Sunk costs”
Conclusions

- Long lags, lack of market prices, and attribution errors create information deficiencies for program evaluation.
- ARS plays a coordinating role for development of technologies that improve water quality and methodologies for measuring impact.
  - Within USDA
  - Across Federal government
Conclusions

- In addition to research results and usable technologies, ARS provides analytical tools for program evaluation:
  - Different levels of spatial scale, integration
- Program evaluation balances appropriate use of these tools and opportunities for finer-grained studies